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2180A

Digital Thermometer

Instruction Manual

P/N 489211
June 1978
REV. 2, 9/88

FLUKE

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SHIPPING TO MANUFACTURER FOR REPAIR OR ADJUSTMENT

All shipments of JOHN FLUKE MFG. CO., INC., instruments should be made via United Parcel Service or "Best Way"* prepaid. The instrument should be shipped in the original packing carton; or if it is not available, use any suitable container that is rigid and of adequate size. If a substitute container is used, the instrument should be wrapped in paper and surrounded with at least four inches of excelsior or similar shock-absorbing material.

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The instrument should be thoroughly inspected immediately upon original delivery to purchaser. All material in the container should be checked against the enclosed packing list. The manufacturer will not be responsible for shortages against the packing sheet unless notified immediately. If the instrument is damaged in any way, a claim should be filed with the carrier immediately. (To obtain a quotation to repair shipment damage, contact the nearest Fluke Technical Center.) Final claim and negotiations with the carrier must be completed by the customer.

The JOHN FLUKE MFG. CO., INC., will be happy to answer all applications or use questions, which will enhance your use of this instrument. Please address your requests or correspondence to: JOHN FLUKE MFG. CO., INC., P.O. BOX C9090, EVERETT, WASHINGTON 98206, ATTN: Sales Dept. For European Customers: Fluke (Holland) B.V., P.O. Box 2269, 5600 CG, Eindhoven, The Netherlands.

*For European customers, Air Freight prepaid.

John Fluke Mfg. Co., Inc., P.O. Box C9090, Everett, Washington 98206

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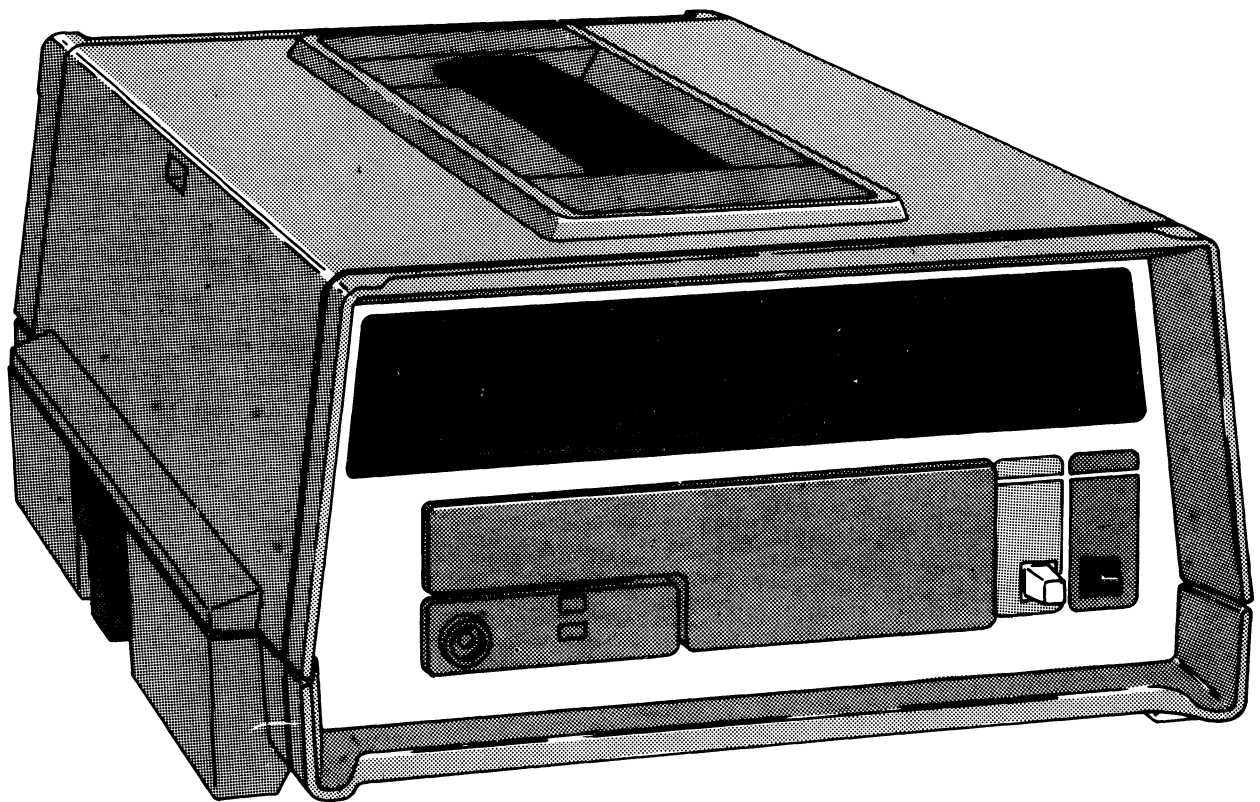
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* For 2180A curve fit Linearizations

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Model 2180A Digital Thermometer

Table 1-2. RTD Total Instrument Accuracy Specifications (cont)

RTD Type	Resolution	Temperature Range Applicable Portion of		Maximum Error* +/-DEGREES C +/-DEGREES F					
		°C	°F	AT CAL	90 DAYS 20° to 30°	1 YR. 15° to 35°	AT CAL	90 DAYS 68° to 86°	1 YR. 59° to 95°
100 ohm	.01°	-200 to 0 0 to 204	-327.9 to 32 32 to 399.2	.009 .009	.055 .098	.078 .139	.015 .015	.100 .177	.142 .252
390 Pt	.1°	-200 to 0 0 to 750	-327.9 to 32 32 to 1382.2	.08 .08	.10 .23	.11 .32	.13 .13	.16 .41	.19 .57
100 ohm	.01°	-200 to 0 0 to 204	-327.9 to 32 32 to 399.2	.040 .040	.086 .13	.109 .171	.071 .071	.156 .234	.198 .309
3916 Pt	.1°	-200 to 0 0 to 750	-327.9 to 32 32 to 1382.2	.11 .10	.12 .26	.14 .34	.17 .17	.21 .46	.24 .62
100 ohm	.01°	-200 to 0 0 to 204	-327.9 to 32 32 to 399.2	.008 .009	.055 .098	.078 .139	.014 .014	.099 .177	.141 .252
392 Pt	.1°	-200 to 0 0 to 750	-327.9 to 32 32 to 1382.2	.08 .08	.01 .23	.11 .32	.12 .12	.16 .41	.19 .57
100 ohm	.01°	-60 to 0 0 to 93	-76 to 32 32 to 199.4	.129 .129	.157 .176	.172 .199	.230 .231	.282 .317	.308 .359
617 Ni	.1°	-60 to 0 0 to 177	-76 to 32 32 to 350.6	.19 .19	.20 .22	.21 .25	.33 .33	.35 .39	.36 .44
10 ohm	.01°	N/A							
CU	.1°	-75 to 0 -75 to 150	-103 to 32 -103 to 302	.16 .16	.18 .20	.19 .23	.27 .27	.31 .35	.34 .41
ohms		0 to 196.99 0 to 999.99	.005 .05	.042 .22	.059 .31	ALL UNITS IN OHMS			
* Maximum error depends on the temperature measured and the resolution used. Of the four temperature ranges presentd for each RTD, the first two represent .01° resolution. The above maximum error numbers represent instrument errors only, and do not include the RTD probe.									

Table 1-3. IPTS 68 Coefficients*

RTD TYPE	RTD LINEARIZATION COEFFICIENTS
100 OHM 385 Pt	DIN 43760 TABLE
100 OHM 390 Pt	ALPHA = 0.0038994 DELTA = 1.494 A4 = -0.265668 ^{10⁻⁴} C4 = -0.205984 ^{10⁻¹¹}
100 OHM 3916 Pt	ALPHA = 0.003916 DELTA = 1.505 A4 = -0.099668 ^{10⁻⁵} C4 = -0.192912 ^{10⁻¹³}
100 OHM NI	ALPHA = 0.00617
10 OHM CU	RO = 9.042 OHM R25 = 10.005 OHM ALPHA = .004260
* SEE NBS MONOGRAPH 126	

Table 1-4. General Specifications

DIMENSIONS 10.49 cm H x 20.45 cm W x 32.64 cm D (4.13 in H x 8.05 in W x 12.85 in D)	RELATIVE HUMIDITY ≤80%, non-condensing, 0 to 50°C
WEIGHT 2.1 kg (4 lbs. 9 oz.)	SHOCK AND VIBRATION Meets MIL-T-28800 specifications
OPERATING POWER 12V dc or 100, 120, 220, 240V ac ±10%, selectable 50 to 400 Hz; 8W typical, 14W max.	INPUT CONNECTION 4-wire to screw terminal block
WARM-UP to RATED ACCURACY 5 minutes	INPUT IMPEDANCE 1000 Mohms at DC
STORAGE TEMPERATURE -40°C to +75°C (Y2009 and Option 21X0A-004: 0 to 40°C)	STABILITY ±175 ppm in 90 days, ±200 ppm per year

Table 1-4. General Specifications (cont)

OPERATING TEMPERATURE 0 to 50°C (Y2009: 0 to 40°C)	TEMPERATURE COEFFICIENT ±15 ppm/°C from 25°C
ACCURACY vs WIRE LENGTH No lead resistance error 4-wire RTD's if R ₂ adjustment on the RTD Input Module is used. Otherwise, 0.04°C/Ω resistance of any one input lead if R ₂ is not adjusted.	RTD EXCITATION CURRENT Nominal 0.5 mA.
DISPLAY °F or °C, switch-selectable, 7-segment LEDs 1.1 cm high	COMMON MODE VOLTAGE 350V dc, 250V ac rms max.
RESOLUTION 0.01° below 204°C for platinum RTD's, automatically shifting to 0.1° above 204°C (93°C for nickel RTD's). If readings are decreasing, shift is at 77°C for platinum, 66°C for nickel.	NORMAL MODE REJECTION ≥90 dB at DC, 50, 60, and 400 Hz ±0.1%.
MEASUREMENT METHOD Dual slope integration, under microcomputer control. 100 ms integration period, three readings per second. A/D Resolution is 100,000 counts at full-scale.	RESPONSE TIME 1 second typical.
LINEARIZATION TECHNIQUES Computer algorithm, 4th order curve fit.	ZERO DRIFT Automatic zero correction.
COMMON MODE REJECTION ≥160 dB at DC, 50, 60, and 400 Hz ±0.1% with 100Ω unbalance at inputs.	RTD TYPES 100Ω 385 Pt (DIN), 390 Pt, 3916 Pt, 392 Pt, 100Ω Ni (DIN), 10Ω CU.
SAFETY Protection Class 1 Relates solely to insulation or grounding properties defined in IEC 348.	VOLTAGE RANGE (CALIBRATION ONLY) No annunciator or decimal point. 99999 μV full scale (switch S2 in AUTO), resolution 1 μV 999990 μV full scale (switch S2 in .1), resolution 10 μV

Section 1

Introduction & Specifications

1-1. INTRODUCTION

1-2. The Model 2180A Digital Thermometer is a portable, five digit RTD thermometer. Temperature measurements are possible, depending on RTD type employed, over a range of -219°C to $+664^{\circ}\text{C}$ (-394°F to $+1435^{\circ}\text{F}$) with 0.1° or $.01^{\circ}$ resolution. The instrument features:

1. Front Panel switch selection of Fahrenheit or Celsius readings.
2. Switch selectable RTD inputs.
3. Switch selectable input line voltage.
4. Dual slope measurement techniques.
5. Digital linearization of the RTD inputs.

1-3. DESCRIPTION

1-4. The instrument display features seven, high-intensity, seven segment LEDs, and leading zero suppression. Six of the LEDs are used to display numeric data, with a minus sign for negative temperature readings. The remaining LED displays the selected temperature scale character ($^{\circ}\text{F}$ or $^{\circ}\text{C}$).

1-5. A four connection, screw-type terminal block is provided on the removable Input PCB for RTD connections. Input switch settings on this module will determine the microcomputer program necessary to linearize the desired RTD's input. A precision, four-wire resistance measurement of the RTD is routed through this module to the thermometer's input circuitry.

1-6. Selection of the temperature scale for display is made with a front panel pushbutton. The scale selected, Celsius or Fahrenheit, is displayed as the last character in the temperature reading ($^{\circ}\text{C}$ or $^{\circ}\text{F}$). A scale change can be made at any time, and has no effect on calibration of the instrument.

1-7. Options and accessories available for the 2180A are listed in Table 1-1. More information concerning these items is given in Section 6 of this manual, Option and Accessory Information.

1-8. The measurement range of the 2180A Digital Thermometer is determined by the type of RTD used as the input device. RTD Types and total instrument accuracy specifications are listed in Table 1-2. Linearization of the RTD input is accomplished through toggling of the input switch segments on the RTD Input Module. Switch positions, numbers and applications are printed on the removable module beside the switch.

1-9. Four input line voltages are available for switch selection. Selection may be made for 100, 120, 220, or 240 volts $\pm 10\%$ as required to meet local conditions. Frequency may vary between 50 and 440 Hertz for all voltage selections. Refer to Section 4 of this manual when changing the selected input line voltage. Refer to Section 2, "Input Power" for 12 volt dc operation.

1-10. SPECIFICATIONS

1-11. Specifications for the 2180A Digital Thermometer are given in Table 1-4. These specifications assume that microcomputer type #2 has been installed in your instrument and at power-up the display reads "8002.2"

Table 1-1. 2180A Options and Accessories

ACCESSORY	DESCRIPTION
Y2000	Multipoint Selector, RTD
Y2009	Battery Pack, 12V Rechargeable
Y2010	Rack Panel PTI, single, A size (for Y2000)
Y2014	Rack Panel PTI, single, C size (for 2180A and Y2002)
Y2015	Rack Panel PTI, double, C size (for 2180A and Y2002)
Y2016	7-inch Rack Adapter PTI, single, D size
Y2017	7-inch Rack Adapter PTI, double, D size
Y2020	Panel Mount PTI-DIN, C size (for 2180A and Y2002)
Y2021	145 mm Panel Mount PTI, D size
Y2022	Divider, Thermometer Calibrator
Y2024	Power Cord, 3-way
Y2026B	Cable, Output Unit, RS-232-C
Y2031	Input Module (for 2180A)
Y2035	Thermal Paper (box of 10)
Y2037	Pt 390 RTD Probe
Y2039	Pt 392 Probe

Table 1-2. RTD Total Instrument Accuracy Specifications

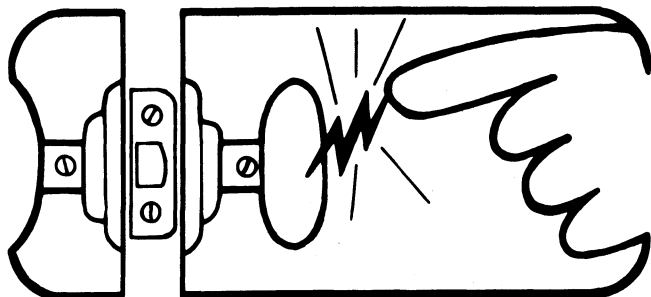
RTD TYPE	RESOLUTION	TEMPERATURE RANGE APPLICABLE PORTION OF		MAXIMUM ERROR*					
				+/--DEGREES C			+/--DEGREES F		
		°C	°F	AT CAL	90 DAYS 20° to 30°	1 YR. 15° to 35°	AT CAL	90 DAYS 68° to 86°	1 YR. 59° to 95°
100 ohm	.01°	-190 to 0 0 to 204	-309.9 to 32 32 to 399.2	.043 .043	.089 .132	.112 .173	.076 .076	.161 .239	.203 .314
385 Pt	.1°	-190 to 0 0 to 750	-309.9 to 32 32 to 1382.0	.11 .11	.12 .26	.14 .37	.18 .18	.21 .46	.24 .62



static awareness



A Message From
John Fluke Mfg. Co., Inc.



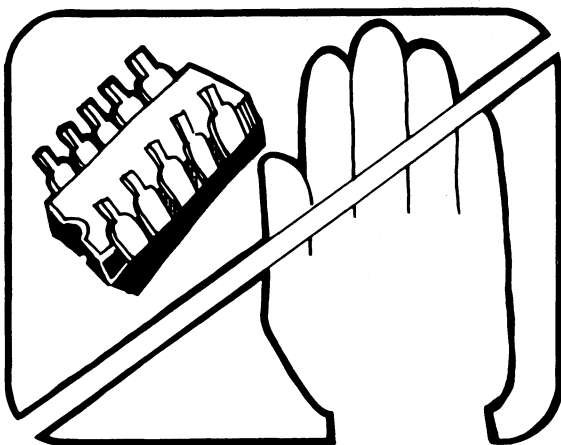
Some semiconductors and custom IC's can be damaged by electrostatic discharge during handling. This notice explains how you can minimize the chances of destroying such devices by:

1. Knowing that there is a problem.
2. Learning the guidelines for handling them.
3. Using the procedures, and packaging and bench techniques that are recommended.

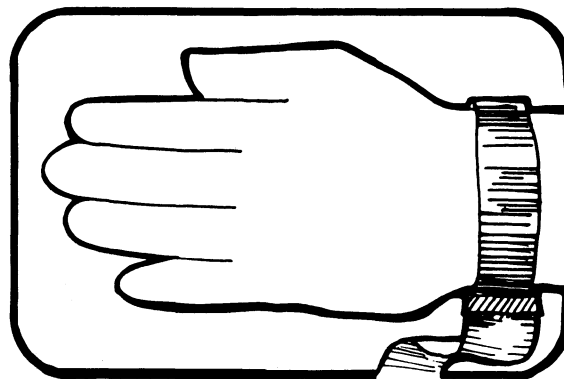
The Static Sensitive (S.S.) devices are identified in the Fluke technical manual parts list with the symbol



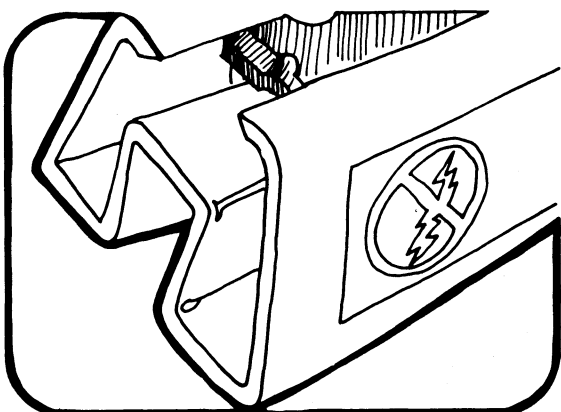
The following practices should be followed to minimize damage to S.S. devices.



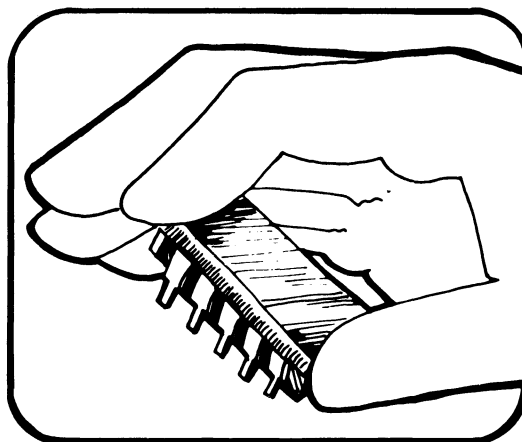
1. MINIMIZE HANDLING



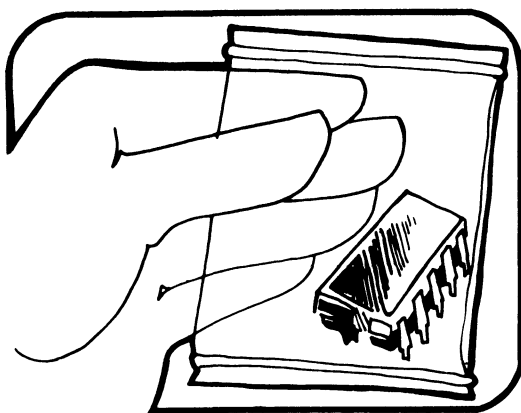
3. DISCHARGE PERSONAL STATIC BEFORE HANDLING DEVICES. USE A HIGH RESISTANCE GROUNDING WRIST STRAP.



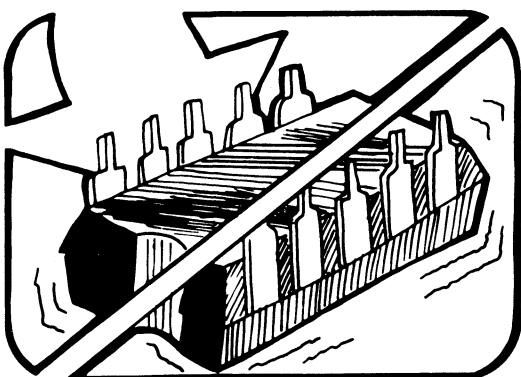
2. KEEP PARTS IN ORIGINAL CONTAINERS UNTIL READY FOR USE.



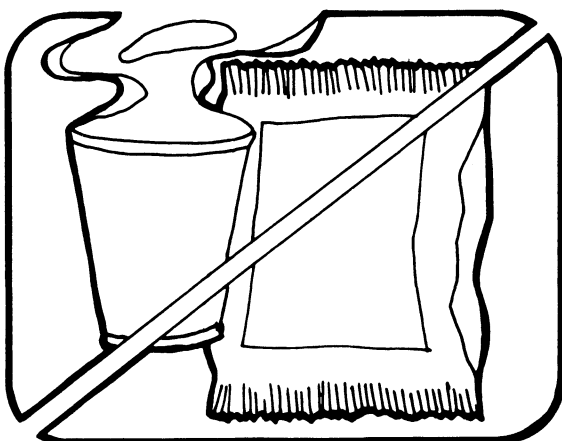
4. HANDLE S.S. DEVICES BY THE BODY



5. USE STATIC SHIELDING CONTAINERS FOR HANDLING AND TRANSPORT

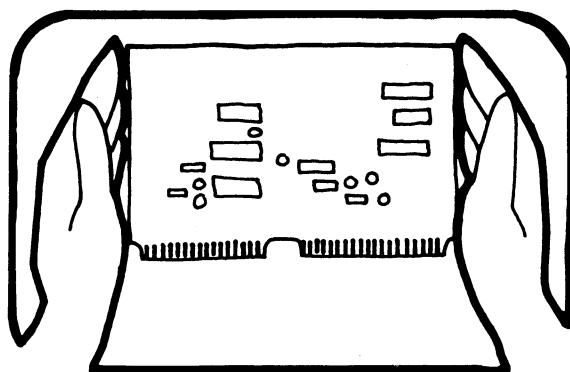


6. DO NOT SLIDE S.S. DEVICES OVER ANY SURFACE

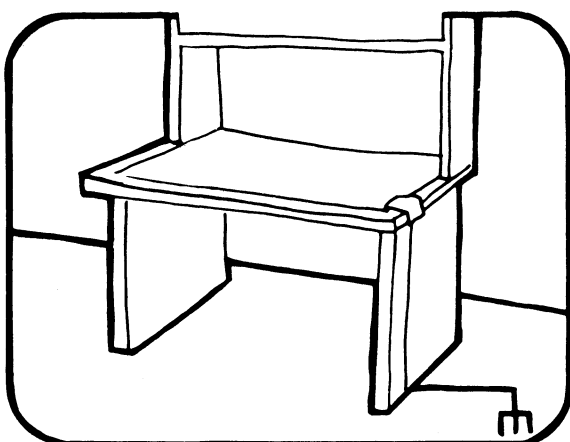


7. AVOID PLASTIC, VINYL AND STYROFOAM® IN WORK AREA

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8. WHEN REMOVING PLUG-IN ASSEMBLIES, HANDLE ONLY BY NON-CONDUCTIVE EDGES AND NEVER TOUCH OPEN EDGE CONNECTOR EXCEPT AT STATIC-FREE WORK STATION. PLACING SHORTING STRIPS ON EDGE CONNECTOR HELPS TO PROTECT INSTALLED SS DEVICES.



9. HANDLE S.S. DEVICES ONLY AT A STATIC-FREE WORK STATION
10. ONLY ANTI-STATIC TYPE SOLDER-SUCKERS SHOULD BE USED.
11. ONLY GROUNDED TIP SOLDERING IRONS SHOULD BE USED.

A complete line of static shielding bags and accessories is available from Fluke Parts Department, Telephone 800-526-4731 or write to:

JOHN FLUKE MFG. CO., INC.
PARTS DEPT. M/S 86
9028 EVERGREEN WAY
EVERETT, WA 98204

Section 2

Operating Instructions

2-1. INTRODUCTION

2-2. This section of the manual contains information regarding installation and operation of the 2180A Digital Thermometer. It is recommended that the contents of this section be read and understood before any attempt is made to operate the instrument. Should any difficulties arise during operation, please contact your nearest Fluke Technical Service Center, or John Fluke Mfg. Co., Inc. P.O. Box C9090, Everett, WA 98206, Tel(206) 356-5400. A list of Technical Service Centers is located in Section 7 of this manual.

2-3. SHIPPING INFORMATION

2-4. The 2180A is packaged and shipped in a foam-packed container. Upon receipt of the instrument, a thorough inspection should be made to reveal any possible shipping damage. Special instructions for inspection and claims are included on the shipping carton.

2-5. If reshipment of the instrument is necessary, the original container should be used. If the original container is not available, a new one can be obtained from the John Fluke Mfg. Co., Inc. Please reference the instrument model number when requesting a new shipping container.

2-6. INPUT POWER

2-7. The 2180A will operate at any of four switch selected input line voltages, all of which operate at frequencies from 50 to 440 Hertz. Before connecting the 2180A to the local ac line, verify that the present setting of the instrument matches the local line voltage. A decal on the instrument rear panel defines the original setting

required for operation. Refer to Section 4 of this manual for instructions on verifying or changing the input line voltage switch settings.

2-8. The rear panel ac input connector is a three-prong, U-ground connector which permits the instrument to be connected, via the power cord, to the applicable line voltage. The offset prong on this connector is attached to the 2180A power supply, and should be connected through the power cord to a high quality earth ground.

2-9. The 2180A will also operate on 12V dc power. A rear panel terminal block, with screw tightened connections, (TB1), allows for ease of attachment. Actual input voltage may vary from 11 to 15V dc; most 12V dc power supplies capable of supplying 1A (e.g., a car battery) can be utilized.

2-10. INSTALLATION

2-11. The 2180A is contained in a special molded plastic instrument case. Other associated accessories used with the 2180A will be packaged in similar PTI (Portable Test Instrument) cases varying only in size. The cases are, in all other respects, compatible and can be stacked vertically and latched together to form miniature portable test systems. Instrument stacks should be limited to a total of 40 pounds.

2-12. Use the following procedure when attaching PTI cases to each other:

1. For the top case, pull out latches found on either side of the instrument.
2. Nestle top and bottom cases together.
3. Push latches in to secure units together.

2-13. Prepare the 2180A for operation by plugging the input line power cord into the applicable power source or connecting the external input connector to an external 12V dc source.

2-14. OPERATING FEATURES

2-15. The location of the 2180A controls, indicators, and connectors is shown and described in Figure 2-1 and Table 2-1 respectively.

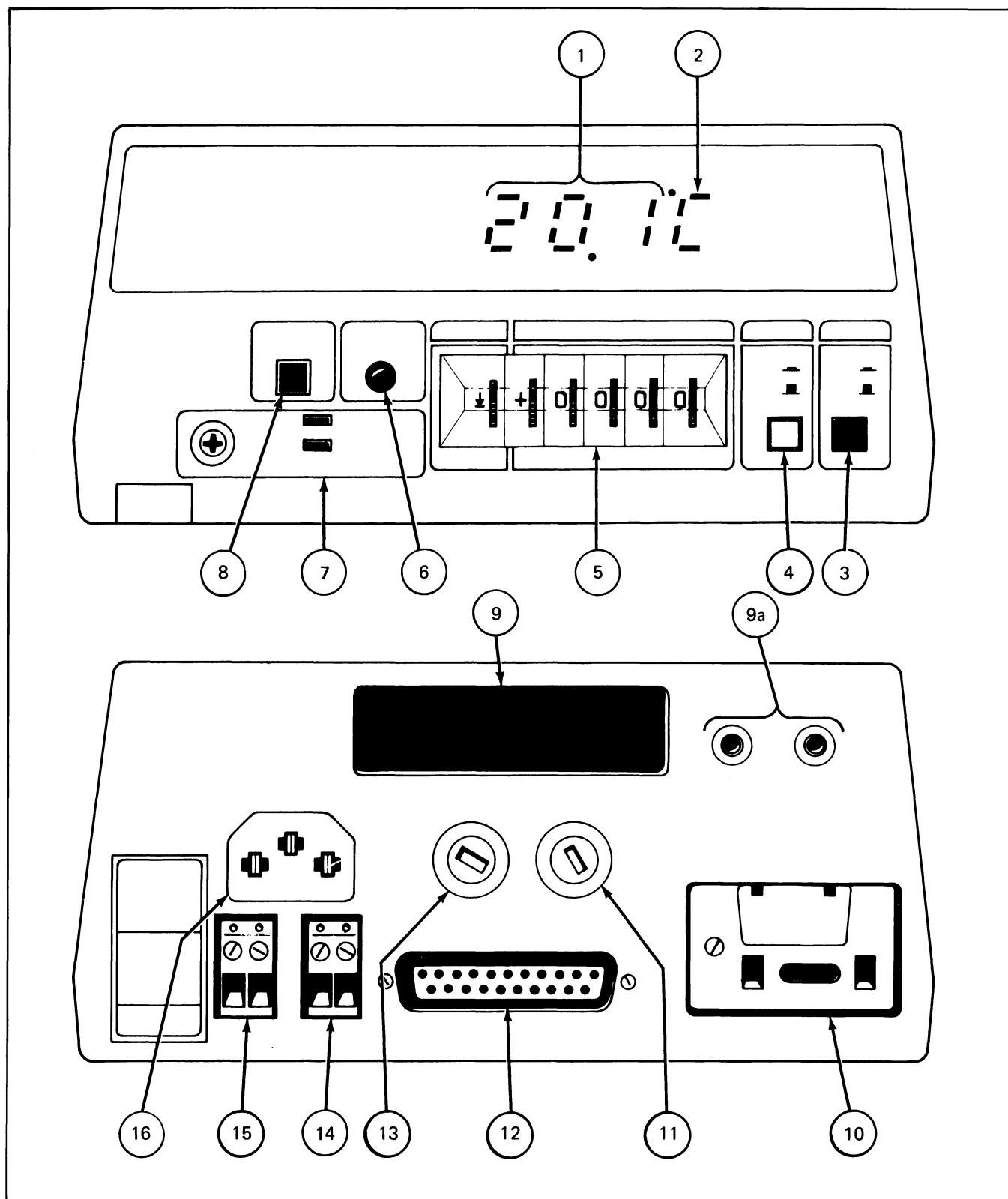


Figure 2-1. Controls, Indicators and Connectors

Table 2-1. Controls, Indicators and Connectors

REF	NAME	FUNCTION
1	Digital Display	Displays a five digit readout of the measured input temperature. Leading zero suppression and a variable position decimal point are included. A minus sign is displayed for negative temperature measurements. Flashes when overranged.
2	Temperature Scale Indicator	Displays the temperature scale represented by the digital display data: °C or °F.
3	Power Switch	Push on/Push off.
4	SCALE	Selects the temperature scale for display: °C or °F.
5	LIMIT and FUNCTION	Part of the —006 Limits Option. When installed, the thumbwheels may be set to a four digit LIMIT value (+ or —). The FUNCTION thumbwheel can then be set to define the limit value and signal (LIMIT EXCEEDED) when the displayed temperature has exceeded the limit value (>, ≤). Display will read the difference between the thumbwheel setting and the actual temperature when (Δ) is set in FUNCTION. Set FUNCTION thumbwheel for storage of maximum (T) or minimum (L) measured since last initializing (no limit value settings).
6	LIMIT EXCEEDED	Part of the —006 Limits Option. Indicator illuminates when the preset limits have been exceeded.
7	CALIBRATION COVER	Sliding cover for calibration adjustments.
8	INITIALIZE MAX/MIN	Part of the —006 Limits Option. Resets the previous maximum and minimum readings stored by the microcomputer.
9	DIGITAL OUTPUT	Connector for the ASCII coded data for the Output Unit, if 21X0A-002 is installed.
9a	ANALOG OUTPUT	Connector for the IEEE-488 if 21X0A-004 is installed (instead of 21X0A-002). Banana jack connector for an Analog Output (1 mV per degree), if 21X0A-002 is installed. (Only used with 21X0A-002.)
10	RTD INPUT MODULE	Removable module houses RTD input connections and type selection switch.
11	F2	External 12V dc input fuse (3/4A MDL slo-blo).
12	ACCESSORY CONNECTOR	Cable connector for accessory bus connection from accessory units.
13	F1	Input line power fuse 1/8A (100 or 120 VAC) 1/16A (220 or 240 VAC). MDL (slo-blo).
14	LIMITS	When the Limits Option is installed, it provides contact closure when the set limit has been exceeded.
15	±12 VDC	Input terminals for the external 12V dc power source.
16	LINE VOLTAGE CONNECTOR	Input connector for the input line voltage.

2-16. OPERATING NOTES

2-17. The following paragraphs describe various conditions that could affect operation of the thermometer. The operator should familiarize himself with these conditions prior to operating the 2180A.

2-18. Option Information

2-19. Supplementary operating instructions are necessary when operating the 2180A equipped with one of the available options. Detailed information regarding the operation of each available option is given in Section 6 of this manual, Option and Accessory Information.

2-20. Fuse Replacement

2-21. The ac line input and external dc input are individually fuse protected. Both fuses are readily accessible on the outside of the rear panel. The ac line input fuse (F1) should be replaced with a 1/8A MDL (slo-blo) fuse if either 100 or 120 volt operation has been selected. Use a 1/16A MDL (slo-blo) replacement for 220 or 240 volt operation. The external dc input (F2) requires a 3/4A MDL (slo-blo) fuse for a replacement.

CAUTION

Remove the power connector from the 2180A before changing fuses.

2-22. RTD Installation

2-23. Use the following procedure when installing an RTD and conducting temperature measurements:

1. Set POWER switch to OFF.
2. Remove the RTD Input Module from the instrument (rear panel).
3. Route the selected RTD lines through the Input Module's rear access port, and connect them to the input terminals; depending on the type of RTD, connections may involve 2, 3, or 4 wires. Refer to Figure 2-2 as a reference when connecting RTD lines to the Input Module (TB1). Lines of the same color usually go to the same polarity connections (+V and +S, or -V and -S). Refer to instructions included with the RTD for specific connection directions.

NOTE

When 2- or 3-wire RTDs are used, there is some error created due to the RTD excitation current in the Sense (S) wire leads. To minimize this error. The user should (when possible) use the 4-wire RTD connection as show in Figure 2-2.

4. On the Input Module, toggle the RTD Selector Switch (S1) to obtain the desired RTD type, see Table 2-2.

NOTE

The RTD Input Module may be printed with microcomputer Type #1 selector switch settings. Refer to Table 2-2 when changing RTD types.

5. Slide the Input Module, RTD lines attached, back into the 2180A securely.

NOTE

Refer to Section 6 of this manual or applicable accessory manuals for instructions on the operation of any installed options or connected accessories.

6. Set POWER switch to ON.
7. Expose the RTD to a temperature within the RTD's specified range (see Specifications in Section 1).
8. The RTD temperature, in the scale selected, is displayed on the front panel.

NOTE

R2 on the 2180A is adjusted at the factory with a 100 ohm input resistance. If the 2180A is used with a 100 ohm 385 Pt RTD probe meeting DIN standard #43760, then the R2 adjustment in the following paragraph may be ignored.

9. Adjust R2 on the RTD Input Module to compensate for variations in lead resistance and in RTD probe Ro values. Refer to Section 4 for RTD input module adjustment procedures. This adjustment must be performed when an RTD probe is initially installed and whenever the leads or the RTD are changed.

NOTE

The RTD adjustment can be used to calibrate the 2180A and the probe near a specific temperature. Adjust R2 for compatibility between the 2180A and a customer supplied temperature reference.

2-24. OPERATING DIRECTIONS

2-25. Operate the 2180A Thermometer using the following procedure:

1. Verify the instrument has the correct RTD connected.
2. Connect the input line cord to the applicable power source.
3. Select the temperature scale desired for display by pressing the Front Panel SCALE switch (in for °C, and out for °F).
4. Set POWER switch to ON.

2-26. Additional Features

2-27. The following paragraphs describe how the 2180A may be used to measure voltage or resistance. In both cases, the RTD will be replaced with a length of standard electrical wire. To connect the standard wire to the RTD Input Module, use steps 1-3 of the RTD Installation procedure, ignoring all reference to the RTD.

2-28. HOW TO MEASURE VOLTAGE

2-29. The 2180A can be used to measure positive voltages only up to +100 mV or +1V maximum in two ranges, with 1 μ V or 10 μ V resolution respectively. To obtain the desired range, refer to the following steps and Figure 2-3.

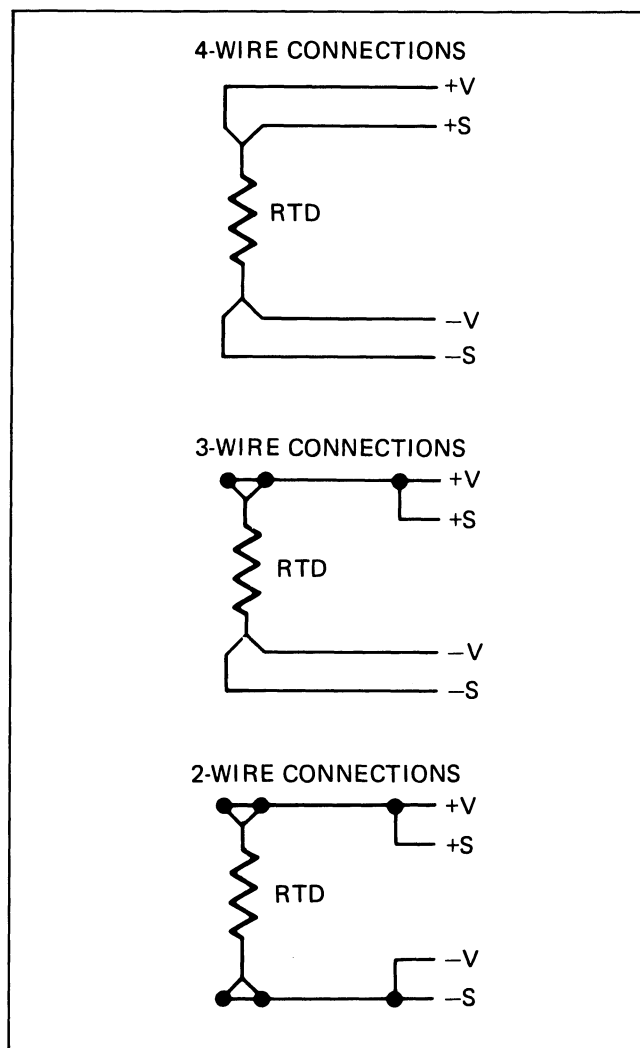


Figure 2-2. RTD Connections

Table 2-2. RTD Input Module Switch Settings

TYPE μ P	DISPLAY READING AT TURN ON	RTD SELECTOR SWITCH (S1) SETTINGS									
		0	1	2	3	4	5	6	7	8	9
2	8002.2	100* 385**	100* 390**	100* 3916**	100* 392**	100* NI	10* CU	—	—	OHM	CAL

* = OHMS

** = PLATINUM

EXAMPLE: To select a switch setting of 5, position the RTD selector switch (1) as shown:

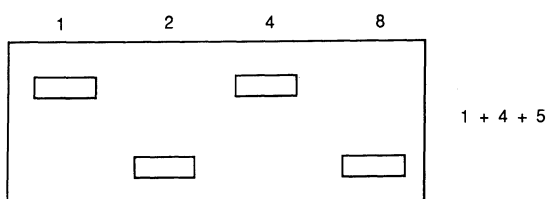


Table 2-3. RTD Input Module Switch Functions

SWITCH NO.	SWITCH POSITION	SWITCH FUNCTIONS
S1	0 - 5	Programs the microcomputer (μ c) for each RTD probe type (See Table 2-2.)
	6, 7	NOT USED
	8	"RESISTANCE", programs the μ c to read ohms.
	9	"CAL", programs the μ c to read μ V (bypasses the linearization program).
S2	.1	Causes the analog to digital converter circuitry (A/D) to have 10 μ V input sensitivity and displays temperature to 0.1° resolution only.
	AUTO	Causes the A/D to automatically change from .01° to 0.1° resolution for overrange or 0.1° to .01° resolution for underrange.
S3	Scan	Not Used
	Man	MUST BE LEFT IN THIS POSITION DURING NORMAL OPERATION.

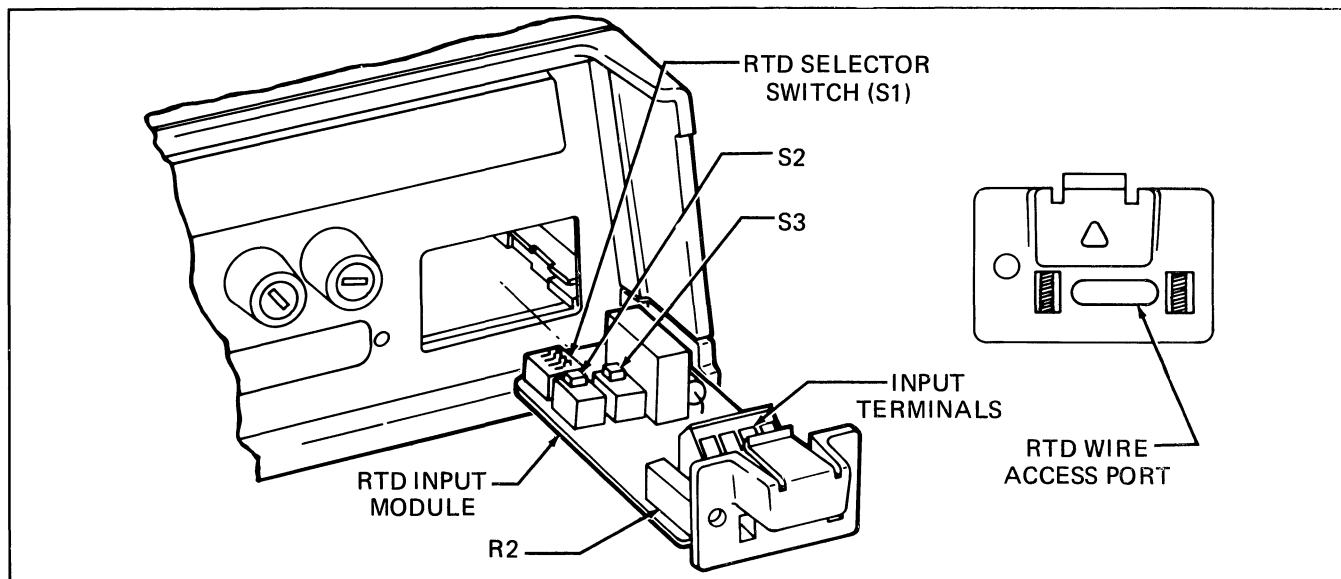


Figure 2-3. RTD Input Module Access

NOTE

The decimal point and temperature scale indicator ($^{\circ}\text{C}/^{\circ}\text{F}$) should be ignored during the following steps, the user must be aware of the selected range.

2-30. 100 millivolt Range

1. Install lead wire to the RTD Input Module, refer to RTD Installation procedures, steps 1-3 (this section).
2. Set RTD Input Module switches, S1 to position 9 and S2 to AUTO.
3. Replace RTD Input Module and turn 2180A on.
4. The 2180A is now ready to measure positive voltages up to +100 mV.

2-31. 1 Volt Range

1. Install lead wire to the RTD Input Module, refer to RTD Installation procedures, steps 1-3 (this section).
2. Set RTD Input Module switches, S1 to position 9 and S2 to .1 $^{\circ}$.
3. Replace RTD Input Module and turn 2180A on.
4. The 2180A is now ready to measure positive voltages up to +1V.

2-32. HOW TO MEASURE RESISTANCE

2-33. The 2180A can be used to measure positive resistances up to 999.9 Ω with 10 m Ω resolution (RTD

excitation ≈ 0.5 mA). To set up the 2180A as a resistance measurement device, refer to the following steps and Figure 2-3.

NOTE

The temperature scale indicator ($^{\circ}\text{C}/^{\circ}\text{F}$) should be ignored during the following steps.

2-34. Resistance Measurements

1. Install lead wires to the RTD Input Module, refer to RTD Installation procedure, steps 1-3.
2. Set RTD Input Module switches, S1 to position 8 and S2 to .1 $^{\circ}$.
3. Connect a known resistance, less than 1 k Ω , to the wires connected to the RTD Input Module, and use the following steps to compensate for lead resistance.
4. Replace RTD Input Module and turn 2180A on.
5. Adjust R2 through the rear panel of the RTD's Input Module until the 2180A's display reads the same value as the known resistance.
6. Remove the known resistance, the 2180A is now calibrated and ready to measure positive resistances up to 999.9 Ω .

NOTE

For measuring resistances of less than 196 Ω , switch S2 on the RTD Input Module should be set to the AUTO position.

Section 3

Theory of Operation

3-1. INTRODUCTION

3-2. This section of the manual contains an overall functional description and a brief circuit analysis of the 2180A Digital Thermometer. Simplified circuit diagrams are provided, as necessary, to supplement the text. Detailed schematics are given in Section 8 of this manual.

3-3. The Model 2180A is a single point RTD Digital Thermometer with 0.1° and $.01^\circ$ resolution for either degrees F or C. This instrument features dual slope A/D conversion, microcomputer control logic, and a 5-digit display with temperature scale indicator. Various RTD types can be used over a temperature range of -394°F to 1435°F (-219°C to 664°C). Refer to Figure 3-1 for the following functional description. Mnemonic definitions are provided in Table 3-1.

3-4. FUNCTIONAL DESCRIPTION

3-5. The Model 2180A executes a continuous series of measurement cycles. These cycles, controlled entirely by a microcomputer, include three major periods: the Auto-Zero, the Integrate, and the Read periods. During each period, digital controls are applied to the analog section of a dual slope converter. The converter in turn generates a compare output. The configuration of the analog section during each phase of the measurement cycle is established by the condition of microcomputer controlled FET switches.

3-6. The measurement cycle begins with the Auto-Zero period. During this period, the input to the Buffer Amplifier is connected to ground through an FET switch and the accumulated dc offset voltages present in the analog section are sampled and held by the Auto-Zero capacitor. This voltage is used later in the measurement cycle to cancel measurement errors introduced by offset voltages in the analog circuitry. The final measurement is

therefore proportional to the RTD probe output voltage and does not include offset errors.

3-7. During the Integrate period, the RTD input voltage read across the RTD, is applied to the integrator. The algebraic sum of the AZ and RTD input voltages is integrated over a 100 ms period. At the end of this period, the RTD input voltage is removed from the integrator, and the Read period is started.

3-8. A reference voltage is applied to the integrator during the Read period, causing the integrator capacitor to be discharged at a linear rate. When the integrator output reaches zero, a compare signal is generated to end the Read period. The duration of the Read period is translated by the microcomputer, to provide a digital indication of the RTD temperature.

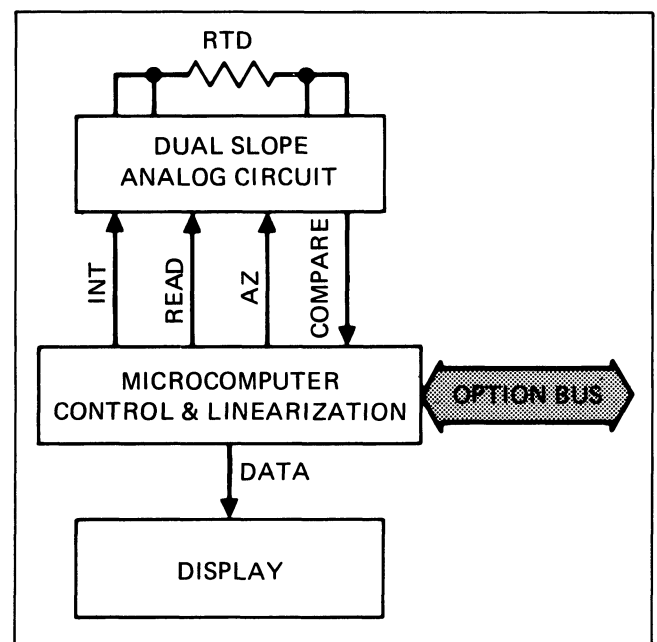


Figure 3-1. 2180A Simplified Block Diagram

Table 3-1. Mnemonics

ANALOG COM	Measurement common
AZ	Auto-Zero
CM	Compare input to the microcomputer
<u>DATA</u>	Data on bus
<u>DCLK</u>	Data clock
DE+	Positive read command
DE-	Negative read command
DIGITAL COM	-15V with respect to Analog Com
D.P./NEG	Drives decimal point, depending on reading and resolution
INT 1	Causes the unknown voltage to be integrated
<u>LINEAR</u>	Used to command the microcomputer to display linear counts
<u>WRT</u>	Write
<u>WRT ADR</u>	Write address, signals that an address is being transmitted
X10	Selects a buffer gain of X10 (0.1° resolution)
X100	Selects a buffer gain of X100 (0.01° resolution)
$\Delta 2$	Hold command
+ SENSE	Voltage sense wires from RTD - no current flows in these wires
-SENSE	Voltage sense wires from RTD - no current flows in these wires
+Vm	An intermediate voltage - not used directly
-V	Current return

3-9. CIRCUIT ANALYSIS

3-10. Circuit analysis of the 2180A is discussed in two sections: digital and analog. The digital section is covered first; particular attention is paid to digital control of the analog section. The analysis of the analog section covers the analog measurement circuitry and the 2180A power supply.

3-11. Digital Section

3-12. The digital section of the 2180A consists of a single-chip microcomputer with a self-contained, programmed, read only memory (U9), a hex CMOS open drain buffer (U13), and an LED display. This section, shown in Figure 3-2, will provide the following functions:

1. Conversion of the non-linear RTD probe voltage, as measured by the analog section, into a linear digital display.
2. Control of the analog section.
3. Control of all accessories on the accessory bus.

3-13. The microcomputer (U9) contains all of the 2180A programming, control logic, and linearizing capability. It also provides all signals necessary to update the display. Linearization of the RTD signal is accomplished by using a piece-wise, 4th order, curve-fit approximation for each

type of RTD. One of the seven operating programs is selected for the RTD type by setting S1 on the RTD Input Module. A table showing RTD switch setting numbers and corresponding RTD types is printed on the RTD Input Module PCB.

3-14. Measurement data is continuously strobed out of the microcomputer in decoded-seven-segment, bit-parallel, character-serial format. This data is then sent to the LED display.

3-15. The total measurement cycle takes 300 ms. The cycle consists of the following periods:

1. Auto-Zero period (100 to 200 ms).
2. Integrate period (100 ms). A 1 ms nominal hold signal is inserted at the beginning and end of the Integrate period to accommodate settling times in the analog section.
3. Read period (variable 0 to 100 ms).

3-16. Analog Section

3-17. ANALOG MEASUREMENT CIRCUIT

3-18. The analog measurement circuitry consists of an RTD input circuit, two voltage reference circuits, a ground sense amplifier, a buffer amplifier, a dual slope

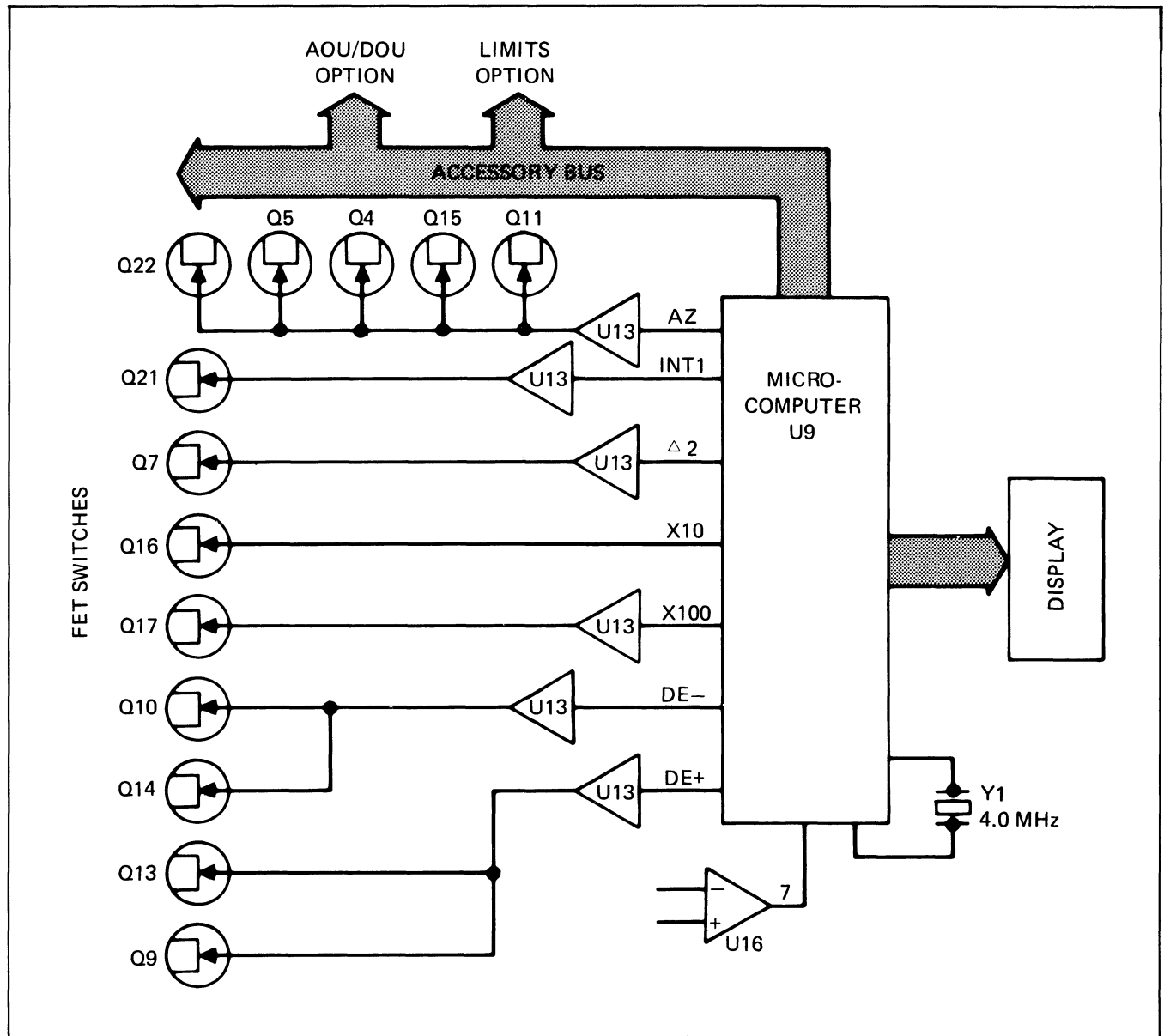


Figure 3-2. Simplified Schematic – Digital

A/D Converter (integrator, gain stage, and comparator), and a combination of FET switches. Refer to Figure 3-3 in conjunction with the following individual circuit descriptions. All FET switches will be shown in their open state; they are closed during measurement cycle commands from the 2180A's digital section.

3-19. The RTD Input circuit comprises the RTD probe, the RTD Input Module, and a low pass filter on the Input Module's PCB. Source current flows through a series combination of the RTD probe, R2 (RTD Input Module), and R1 (Main PCB). The voltage sensed across the RTD is routed through the Input Module, and onto the Main PCB. The +Sense line (always a positive voltage) is then applied to the low pass filter.

3-20. The ground sense amplifier (Q20, U7 and associated circuitry) maintains the -Sense line at measurement ground. This amplifier compensates for noise and offsets on the -V and -Sense lines.

3-21. To achieve switching between 0.01° and .1° resolution, the buffer gain is shifted by a factor of ten. For 0.01° resolution, FET switch Q17 is on, and a reference voltage of -100 mV is applied to the buffer (Q19, U5). The buffer gain is set to 100. For 0.1° resolution, FET switch Q16 is on, and a reference voltage of -1.00V is applied and the buffer gain is 10.

3-22. The first voltage reference consists of a resistor network supplied by an accurate 6.2V dc reference voltage. The resistive divider network is set to provide 200 mV to Q14, 100 mV to Q15, 1.0V to Q11, and 2.0V to Q10.

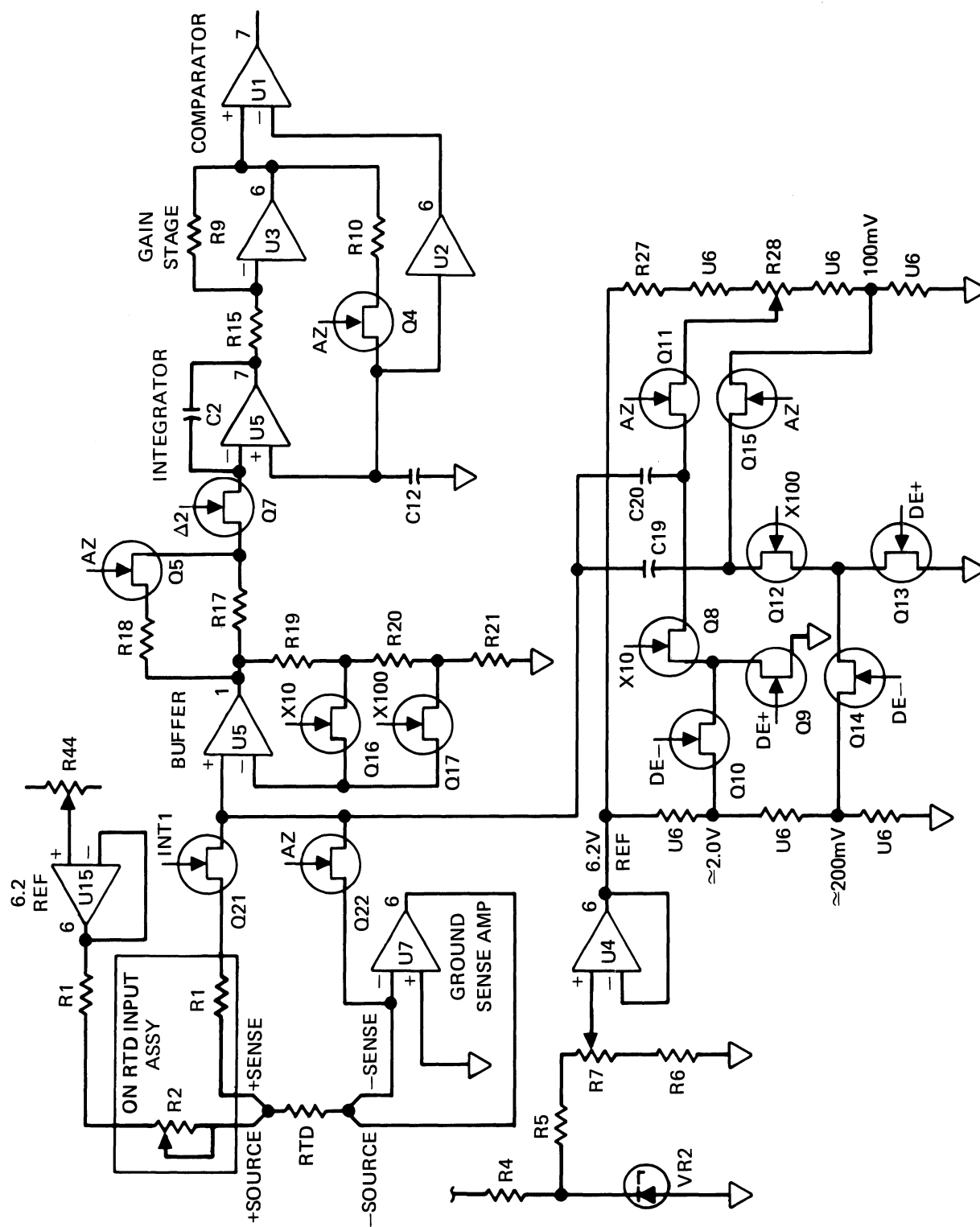


Figure 3-3. Simplified Schematic – Analog

When 0.01° resolution is in use, Q12 will allow reference capacitor C19 to attain a -100 mV charge. For 0.1° resolution, Q8 will allow C20 to charge to ± 1.0 V. Either reference capacitor will be placed at the $-Sense$ level during Auto-Zero. Recovery deintegrate is applied to Q10 and Q14.

3-23. A second voltage reference (U15-6) provides an accurate 6.2 V across the series combination of R1 (Main Thermometer PCB), R2 (RTD Input PCB), and the RTD. This voltage therefore provides the source ($+V$) voltage for the RTD.

3-24. The Buffer, Integrator, Gain Stage, and Comparator Amplifiers combine to perform the analog functions of the Integrate, Read, and Auto-Zero periods. The Buffer is used to provide integrator inputs during all three periods. The Integrator integrates the Buffer output voltage during the Integrate and Read periods and, in combination with the Gain Stage, functions as a closed-loop amplifier during the Auto-Zero period.

3-25. An Auto-Zero period is commanded during the first phase of each measurement cycle. During this time, five auto-zero switches (Q4, Q5, Q11, Q15, and Q22) are closed by the microcomputer. Three of the switches (Q11, Q15, and Q22) charge the reference capacitors to $+100$ mV on C19 and $+1.0$ V on C20. Closing switch Q4 connects the Integrator and Gain Stage into a closed-loop configuration. This action also allows the Auto-Zero capacitor (C12) to charge to a value proportional to the algebraic sum of all the offset voltages in the Buffer, Integrator and Gain Stage. At the end of the Auto-Zero period, switches Q4, Q5, Q11, Q15, and Q22 are opened. The reference capacitors (C19 and C20) and the Auto-Zero capacitor retain their charges for later use in the measurement cycle.

3-26. The Integrate period (see Figure 4-4) starts on the leading edge of the integrate command from the microcomputer; switch Q21 is closed and switch Q7 is opened. The RTD input voltage is applied through switch Q21 to the Buffer input. After a 1 ms settling period, switch Q7 closes, and the Buffer output is applied to the Integrator for 100 ms. As the integrator capacitor C2 charges, the Integrator drives the comparator, through the gain stage to $+5$ V dc which indicates that the charge on C2 is more negative than the Auto-Zero Reference C12. At the end of the Integrate period, the integrate capacitor is charged to a level and polarity proportional to the RTD voltage, and switches Q21 and Q7 return to the open state.

3-27. The Read period starts at the end of the Integrate period. Depending upon the input polarity sensed by the comparator during the Integrate period, one of two Read modes is enabled if a positive input is sensed, a positive

Read mode is enabled. Similarly, a negative Read mode is enabled when a negative input is sensed.

3-28. When the positive Read mode is commanded, FET switches Q13 and Q9 are closed. If 0.1° resolution is in effect, Q8 will place the positive side of reference capacitor C20 at ground. With 0.01° resolution in effect, Q12 will place the positive side of reference capacitor C19 at ground. Reference capacitors C20 and C19 will then apply either -1.0 V or -100 mV, respectively, to the Buffer input.

3-29. When the negative Read mode is commanded, switches Q10 and Q14 are closed; Q9 and Q13 are open. With $.01^\circ$ resolution selected, approximately $+200$ mV will be applied to the positive side of reference capacitor C19. The algebraic sum of the voltage at the Buffer input will then be $+100$ mV. When 0.1° resolution is selected, approximately $+2.0$ V will be applied to the positive side of reference capacitor C20. Buffer input voltage will then be $+1.0$ V (only during recover deintegrate).

3-30. After a 1 ms settling time, switch Q7 closes and the Buffer output voltage is applied to the Integrator input. The integrator capacitor now begins to discharge at a linear rate (determined by the reference voltage). This discharge continues until the integrator voltage reaches the comparator trip point, which is referenced to the voltage on the Auto-Zero capacitor. When this level is reached, the comparator changes state, commanding the microcomputer to terminate the Read period. To facilitate auto-zero, the microcomputer then calls a reference voltage opposite in polarity to the one previously used (DE $-$ or DE $+$). When the integrator reaches the trip point, the microcomputer immediately begins the Auto-Zero period.

3-31. Offset voltages present during the Integrate and Read periods are cancelled by offset voltages that were sampled and held during the Auto-Zero period.

3-32. POWER SUPPLY

3-33. The 2190A Power Supply consists of a DC to DC Converter and regulating circuitry. AC inputs are made via the input power cord, line fuse, and power transformer/rectifier. External $+12$ V dc inputs can also be made directly to the DC to DC Converter circuitry via line TB1 (see Main PCB schematic, Section 8). The function of the power supply is to provide $+5$ V, $+5$ V unregulated, $+15$ V, and -15 V dc operating voltages for the 2180A circuitry. The power supply can be driven from ac line or 12 V dc external source. The DC to DC conversion and voltage regulation is accomplished using conventional power supply design techniques.

Section 4

Maintenance

WARNING

THESE SERVICING INSTRUCTIONS ARE FOR USE BY QUALIFIED PERSONNEL ONLY. TO AVOID ELECTRIC SHOCK, DO NOT PERFORM ANY SERVICING OTHER THAN THAT CONTAINED IN THE OPERATING INSTRUCTIONS UNLESS YOU ARE QUALIFIED TO DO SO.

4-1. INTRODUCTION

4-2. This section of the manual provides information about warranty, factory service, maintenance, performance testing, routine recalibration and recalibration after repair. The performance test is recommended when the instrument is received and later as a preventive maintenance tool or for testing after repair. The test verifies performance at several temperatures within the range of a given RTD type. Specifications are provided both for annual and for a more precise 90-day performance-testing cycle.

4-3. SERVICE INFORMATION

4-4. The instrument is warranted for a period of 1 year upon delivery to the original purchaser. The WARRANTY is located on the back of the title page of this manual.

4-5. Factory authorized calibration and service for each Fluke product is available at various worldwide locations. A complete list of these service centers is included in Section 7 of this manual. If requested, an estimate will be provided to the customer before any work is begun on instruments that are beyond the warranty period.

4-6. GENERAL MAINTENANCE

4-7. Instrument Disassembly and Reassembly

4-8. Disassemble the thermometer using the following procedure (power cord disconnected):

1. Remove the RTD Input Module through its access port in the rear panel.
2. On the bottom of the instrument, remove the four securing screws. Lift the top cover free.
3. Remove the screw securing the center of the Main PCB to the bottom portion of the case.
4. Lift the Main PCB, complete with Front and Rear Panels, clear of the case.
5. Remove the Output Option, if installed and required, by removing the three screws connecting it to the Main PCB, disconnecting the interconnect cables at J1 and J3, and lifting the Output Option PCB clear.
6. Remove the Front Panel, if required, by disconnecting the guard screw at the lower right corner; disconnecting the Front Panel Interconnect cable at J6; disconnecting, if installed, the Limits Option interconnect cable at J4; and moving the Front Panel forward.
7. Remove the Rear Panel, if required, by removing the three screws attaching it to the Main PCB, disconnecting the wires from the input line power connector, unsoldering the wires from two fuse holders and moving the rear panel free.
8. Perform reassembly in the reverse order.

4-9. Input Power

4-10. Input line power voltage is selected by positioning the two switches on the right edge of the Main PCB. Each switch (S3 and S4) has a position identifying slot; Figure 4-1, shows these slots positioned for 120V ac operation. Table 4-1 lists the switch settings for other line voltages.

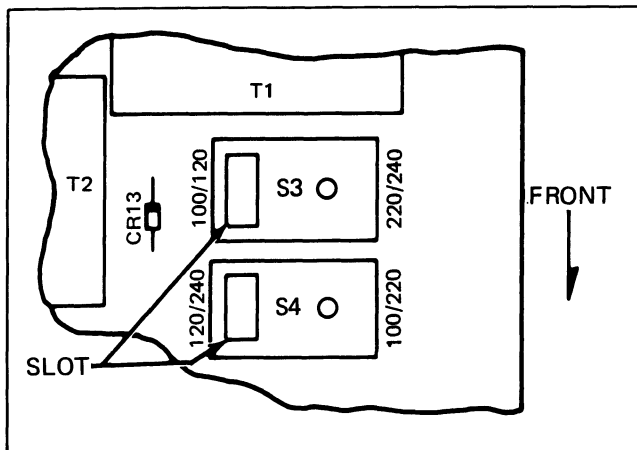


Figure 4-1. Line Voltage Selection

Table 4-1. Line Voltage Selection

VOLTAGE	S3 SLOT (REAR SW)	S4 SLOT (FRONT SW)
100	Left	Right
120	Left	Left
220	Right	Right
240	Right	Left

4-11. Cleaning

4-12. Clean the instrument periodically to remove dust, grease and other contamination. Use the following procedure:

CAUTION

Do not use aromatic hydrocarbons or chlorinated solvents for cleaning. They will react with plastic materials used in the manufacture of the instrument.

1. Clean the front panel and case with a soft cloth dampened with a mild solution of detergent and water.
2. Clean the surface of the pcb using clean, dry air at low pressure (≤ 20 psi). If grease is encountered, spray with Freon T.F. Degreaser or anhydrous alcohol and remove grime with clean, dry air at low pressure.

4-13. Fuse Replacement

WARNING

DISCONNECT THE UNIT FROM LINE POWER BEFORE ATTEMPTING FUSE REPLACEMENT.

4-14. The 2180A has two fuses, both accessible on the rear panel. F1 is for the input line power and should be replaced, when necessary, with a 1/8A MDL (slo-blo) fuse when the input line power selected is 100V or 120V. When the input power selected is 220V or 240V, F1 should be replaced with a 1/16A MDL fuse. F2 is for the 12V dc external power and requires a 3/4A MDL fuse.

4-15. Service Tools

4-16. No special tools are required for maintenance or repair.

4-17. Static Discharge Precautions

4-18. Static discharge can damage components contained in the 2180A. The following precautions should be observed when conducting adjustments or repairs with the instrument's top cover removed.

1. Never conduct repairs without first pressing power OFF, disconnecting the line cord and accessory bus cable from the ACCESSORY CONNECTOR.
2. Perform all repairs at a static-free work station.
3. Minimize handling of ICs and the pcb; in no case handle them by their connectors.
4. Keep repair parts in their original container until ready for use.
5. Use static ground straps to discharge repair personnel.
6. Use conductive foam or anti-static containers to store replacement or removed ICs.
7. Remove all plastic, vinyl, and styrofoam products from the work area.
8. Do not slide static sensitive devices over any surface.
9. Use only anti-static type solder removal tools.
10. Use grounded tip soldering irons.

4-19. PERFORMANCE TEST

4-20. The Performance Test verifies instrument performance to specifications and may be used for initial acceptance, verifying calibration, or as an aid in troubleshooting. If the thermometer fails to meet specifications either the Calibration Adjust Procedure or Troubleshooting should be performed, as determined by qualified service personnel.

4-21. Table 4-2 lists the equipment required for the Performance Test and Calibration Adjustment Procedure. If the recommended model of test equipment is not available, a substitute that meets the minimum use specifications may be used. The test should be conducted with an ambient temperature of $25 \pm 5^\circ\text{C}$ ($73.4 \pm 9^\circ\text{F}$).

4-22. Use the following procedure for the Performance Test:

1. Set the POWER switch to OFF and remove the line power cord from the line voltage source.
2. On the RTD Input Module, position S1 to 9 and S2 to AUTO.
3. Connect the equipment as shown in Figure 4-2. Refer to Table 4-2 for Recommended Test Equipment.
4. Verify the POWER switch is OFF, then adjust the line voltage transformer for the nominal input line voltage.
5. Set the POWER switch to ON.
6. Allow the thermometer to stabilize (at least 20 minutes).
7. On the Decade Resistance Box, select 100.00Ω and adjust R2 on the RTD Input Module for a display of "51240" (equivalent to 0°C or 32°F).
8. Refer to that portion of Table 4-3 pertaining to the RTD(s) in use.
9. On the Decade Resistance Box, select the first resistance listed in Table 4-3 for the RTD type being verified.
10. On the RTD Input Module, set the selector switch for the RTD type to be verified (0-5). Refer to Table 2-2 for switch settings.

11. Verify that the 2180A reading is within the tolerance listed in Table 4-3 (90-day or 1-year).

12. Repeat steps 9, 10, and 11 for the remaining resistances listed for the RTD type being verified.

13. Repeat steps 9-12 for as many RTD types as necessary.

14. Set the line voltage transformer for line voltage minus ten percent and repeat the test for one RTD type.

15. Set the line voltage transformer for line voltage plus ten percent and repeat the tests for one RTD type.

16. Set the line voltage transformer for the input line voltage.

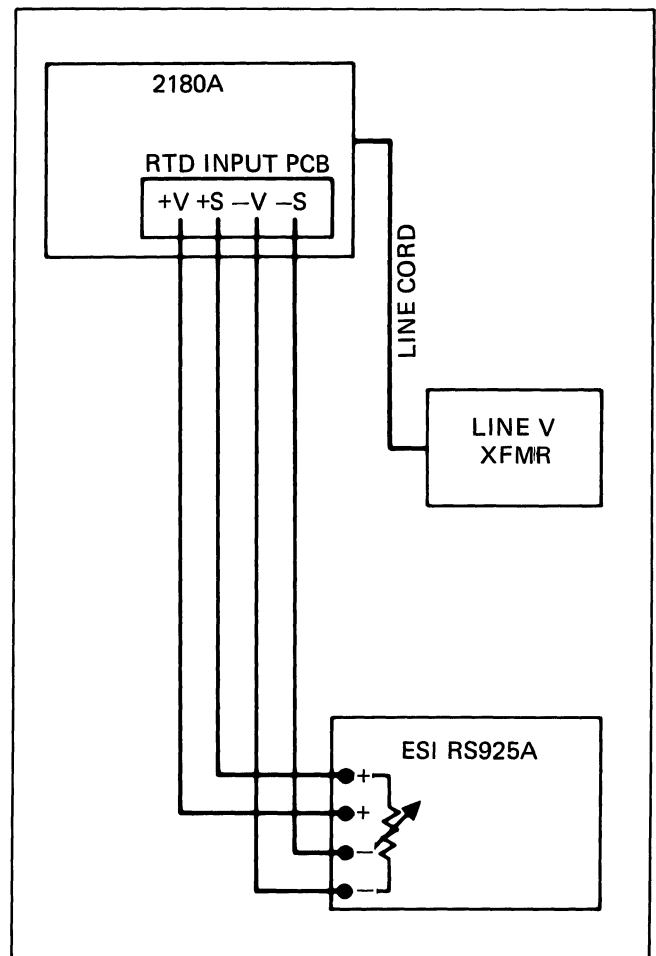


Figure 4-2. Performance Test Connections

Table 4-2. Recommended Test Equipment

TEST EQUIPMENT	MINIMUM USE SPECIFICATIONS	RECOMMENDED MODEL
Variable Line-Voltage Transformer	100, 120, 220, 240V ac, as required, $\pm 10\%$	General Radio VARIAC W5HM
Decade Resistance Box	.01 Ω resolution	General Radio 1433T, ESI Model RS925A, or equivalent.
Voltage Divider	100:1	Fluke Y2022 or equivalent
Calibrator (DC Source)	10 μ V resolution	Fluke 343A or equivalent
Digital Voltmeter (± 100 μ V)	100 μ V resolution, on 10V range	Fluke 8800A or equivalent
Lag Bath	Temperature Stable, .01 $^{\circ}$ resolution	Customer Constructed. (See Lag Bath Construction, this section)

4-23. CALIBRATION

4-24. The thermometer should be calibrated at either 90-day or annual periods, depending upon the accuracy desired, and any time that repairs are made to the instrument. Conversion between Fahrenheit and Celsius scales is realized through a mathematical computation by the microcomputer. Calibration in $^{\circ}$ F is recommended. Calibration in either scale ($^{\circ}$ F or $^{\circ}$ C) insures the accuracy of the other. Either scale can be verified by executing the Performance Test.

4-25. Equipment Preparation

4-26. Prepare the equipment for calibration using the following procedure:

1. Remove the top cover from the instrument.
2. Apply power to 2180A and all test equipment to be used. Insure the 2180A warm-up period has been sufficient to reach rated accuracy (at least 20 minutes).
3. Select the desired temperature scale ($^{\circ}$ C or $^{\circ}$ F). If the Limits Option is installed select the LIMITS (\leq or $>$) function.

NOTE

Before removing the RTD Input Module, set power switch to OFF.

CAUTION

Do not connect analog common (0V) to digital common (-15V with respect to analog common). Instrument damage may result.

4-27. Reference Adjust

4-28. Perform Reference Adjust using the following procedure:

1. Connect the DVM between TP16 and TP1 (Analog Common).
2. Adjust R7 for a reading of 6.2V ± 100 μ V.

4-29. Reference Adjust (+V)

4-30. Perform the Reference Adjust for the +V using the following procedure:

1. Connect the DVM to TP17 (HI) and TP1 (LO - Analog Common).
2. Adjust R44 to obtain a reading of 6.2V ± 100 μ V.

4-31. Zero Adjust

4-32. Perform the Zero Adjust using the following procedure:

1. Connect the 2180A Digital Thermometer, DC Voltage Calibrator, and Voltage Divider as illustrated in Figure 4-3.
2. On the RTD Input Module, place a jumper between -V and -S on TB1. Select AUTO (S2 on the Input PCB).

Table 4-3. 2180A Performance Tests

OHM INPUT	SELECT SWITCH	READING		90 DAY		1 YEAR	
		°F	°C	°F	°C	°F	°C
39.650	(0)	-238.00	-150.00	.100	.054	.104	.057
212.030	100 ohm	572.0	300.0	.30	.17	.32	.19
345.210	385 Pt	1292.0	700.0	.44	.25	.49	.27
38.777	(1)	-238.00	-150.0	.044	.024	.049	.027
213.472	100 ohm	572.0	300.0	.25	.14	.28	.16
348.446	390 Pt	1292.0	700.0	.42	.24	.47	.26
38.679	(2)	-238.00	-150.00	.100	.055	.105	.058
213.929	100 ohm	572.0	300.0	.28	.16	.30	.17
349.323	3916 Pt	1292.0	700.0	.42	.24	.47	.26
38.612	(3)	-238.00	-150.00	.044	.024	.049	.027
214.135	100 ohm	572.0	300.0	.25	.14	.28	.16
349.909	392 Pt	1292.0	700.0	.39	.21	.43	.25
71.80	(4)	-67	-55.00	.26	.15	.27	.15
161.70	100 ohm	212	100.0	.37	.21	.38	.22
219.00	NI	347	175.0	.39	.22	.40	.23
6.201	(5)	-100	-73.3	.33	.19	.34	.19
14.778	10 ohm	300	148.9	.35	.20	.37	.21
	CU						

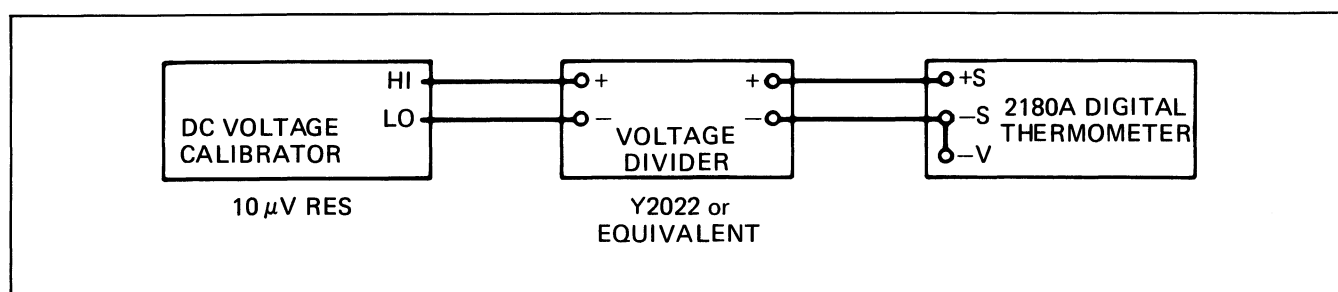


Figure 4-3. Calibration Connections

3. Toggle the RTD select switch for setting 9. Toggle S3 to manual position.
4. On the 2180A front panel, access calibration adjustments behind the cover in the lower left corner. Loosen the screw and slide the cover to the left.
5. Set the calibrator output to 0.00102V and divider to +100 (10.2 μ V to 2180A). Note the 2180A reading. Now reverse the input polarity and again note the reading. Adjust R29 (access beneath front panel calibration cover-ZERO) until the readings in both directions are the same.
6. Adjust R14 (Main PCB) for a reading of +10. Reverse input polarity and look for a 2180A reading of -10. Repeat steps 4 and 5 if a reading of -10 is not obtained.

4-33. Resolution Adjustments

4-34. Use the following procedure to adjust the 2180A's .01° and .1° display and the verify autoranging operation.

1. Replace the 2180A's top cover. Leave test equipment connected (DC Voltage Calibrator, Voltage Divider) as described in Zero Adjust instructions.
2. On the 2180A front panel, access calibration adjustments by loosening the screw and sliding the cover to the left.
3. On the RTD Input Module, set S2 to AUTO. Set input switch S1 to setting 9 (CAL).
4. Set the DC Voltage Calibrator output to 9.9V (99 mV to the 2180A).
5. Adjust R27 (.01° cal potentiometer) for a reading of 99000 \pm 1.
6. Change the calibrator output to 4.5V (45 mV to 2180A). The 2180A should read 45000 \pm 2.
7. Set switch S2 out of AUTO. Set DC calibrator output to 9.9V and the divider to 10 (990 mV to 2180A).
8. Adjust R28 (.1° cal potentiometer) for a reading of 99000 \pm 1.
9. Change the calibrator output to 4.5V, the 2180A should read 45000 \pm 2 (450 mV to 2180A).
10. Place S2 in the AUTO position.

4-35. RTD Input Module Adjustment

4-36. Use the following procedure whenever 2180A calibration or repair has been accomplished or when a different RTD probe is installed.

1. Connect the RTD probe to the RTD Input Module (TB1).
2. Select the applicable input switch setting (S1) and insert the probe into a ice bath. Refer to the following paragraph for a suggested method of constructing a ice bath.
3. Install the RTD Input Module in the 2180A. Apply power to the 2180A.
4. Adjust R2 (access through the rear hole on RTD Input Module) until the 2180A displays the ice bath temperature.
5. Calibration of the 2180A is now complete. Disconnect all test equipment from the instrument.

4-37. Ice Bath Construction

4-37. Ice Bath Construction

4-38. The following instructions provide a recommended method of constructing a ice bath:

NOTE

Distilled water must be used to make the ice and must also be used in the ice bath.

1. Required material; supply of ice, distilled water, and an insulated jar with an unbreakable lid (thermos or equivalent).
2. Prepare the insulated jar by drilling one or more holes just large enough to accept the RTD Probe or Probes.
3. Fill the insulated jar with shaved or crushed ice.
4. Fill the insulated jar with enough distilled water so that the ice becomes slush but not enough to float the ice.

NOTE

As the ice melts, siphon off the excess water and add more ice. Allow about 5 to 10 minutes for the water to drop back to the freezing point.

4-39. SELECTED COMPONENT REPLACEMENT

4-40. Certain components in the two 6.2V reference supplies are supplied as a matched set. If a component in either set is replaced, all the components in that set must be replaced with a matched set supplied by John Fluke Mfg. Co., Inc. The two sets include R4, R5, and VR2 in the 6.2V reference and R43, R46, and VR5 in the 6.2V (V+) reference.

4-41. TROUBLESHOOTING

4-42. Troubleshooting for the 2180A consists of the tabular flow chart in Table 4-4. When a step on the flow chart is completed check for a decision transfer. If no decision is required perform the next step of the table in sequence. Refer to Figure 4-4 for test point location and Table 4-5 for test point identification.

Table 4-4. 2180A Troubleshooting

STEP NO.	ACTION	Go to the step number given for correct response	
		YES	NO
1	Input 0 volts from the divider to +S (HI); -S, -V (LO); leave +V disconnected.		
2	Set the RTD selector switch to setting 9 (Cal).		
3	Apply power to the thermometer.		
4	Does the display read 2180.X for ten seconds and then change to 0°C (0°F)?	14	5
	NOTE <i>X = a numeral depending on the version of software installed.</i>		
5	Does any portion of the display illuminate?	13	6
6	Measure between TP2 (REF) and TP4 for +5 ±10% VDC, between TP1 (REF) and TP3 for +15 ±5% VDC.		
7	Are all voltages correct?	12	8
8	Measure between pin 8 of T2 and the negative end of C26 for a DC voltage greater than 10.3V and for a peak-to-peak wave form between pins 8 and 9 of T2 approximately twice the value of the DC voltage measured at pin 8.		
9	Are both signals present and correct?	11	10
10	Check the inverter circuit that drives the transformer (T2). Repair as required then resume at step 3.		
11	Check the transformer secondaries and if any are bad, check the individual regulators and their associated components. NOTE: Analog circuitry may load down the ±15V supplies. Repair as required then resume at step 3.		
12	Check the +5V path to the Display PCB and the Display PCB Connector. Repair as required then resume at step 3.		
13	Check the strobes (U9-3, 4, 5, 6, 19) and display seven segment control lines (U9-8, 9, 10, 11, 12, 13, 14). Repair as required then resume at step 3.		
14	Set the RTD selector switch to the setting of the type RTD to be connected in the next step.		
15	Connect an RTD to the thermometer and measure some known temperature. (A lag bath is suggested.)		
16	Is the displayed temperature correct?	37	17
17	Check the RTD components and the ground sense buffer amp (U7, Q20 and their associated components). Repair as required then resume at step 14.		
18	Can the Calibration Adjustment Procedure be performed?	37	19
19	Are control signals at U9 pins 26, 27, 30, 31, 32 toggling between high and low logic levels? NOTE: the X100 signal at pin 33 of U9 will remain low (0V) unless unit is in 0.1° Range. (Use TP2 as common.)	21	20
20	Replace the microcomputer U9, then resume at step 14.		
21	Are the outputs of U13 toggling between high and low logic levels? NOTE: The output at pin 1 of U13 will remain low (0V) unless 2180 is in 0.1° Range.	23	22

Table 4-4. 2180A Troubleshooting (cont)

STEP NO.	ACTION	Go to the step number given for correct response	
		YES	NO
22	Check U13, Q27 and their associated components. Repair as required then resume at step 14.		
23	Is the waveform at TP7 as shown in Figure 4-4 (Magnitude & Polarity varies with the input signal)?	30	29
24	Is there 6.2 Vdc at TP16? (Use TP1 as common.)	26	25
25	Check the Reference Circuit providing an input at U4-3 from the divider R4, R5, R6, R7 and VR2. Repair as required then resume at step 14.		
26	Check from TP1 (analog ground) to U6-6 for 100 mV dc and for approximately 200 mV dc at U6-9.		
27	Are both voltages present?	29	28
28	Check Q8, Q9, Q10, Q11, Q12, Q13, Q14, Q15 and their associated components. Repair as required then resume at step 14.		
29	Check the RTD Input Module plus U5-1, Q19, Q21, Q22, and their associated components. Repair as required then resume at step 14.		
30	Is the waveform at U5-7 as shown in Figure 4-4 (Magnitude & Polarity varies with the input signal)?	34	31
31	Check the operation of Q5, Q6, Q7, Q18, U5 and their associated components. If any defective components are found, repair as required and resume at step 13. If none are found proceed to the next step.		
32	Connect TP2 and TP6 with a jumper to lock the instrument in the Auto Zero period.		
33	Check U5, U3, U2, Q4 and their associated components. This circuit should now function as a closed loop amplifier. Repair as required. Remove the jumper between TP2 and TP6 and resume at step 14.		
34	Does TP10 toggle between the high and low logic levels?	36	35
35	Check U1 and its associated components then resume at step 14.		
36	Replace the microcomputer U9, then resume at step 14.		
37	Troubleshooting of the 2180A is complete. Remove all test equipment, reconnect any cables removed and close the instrument.		

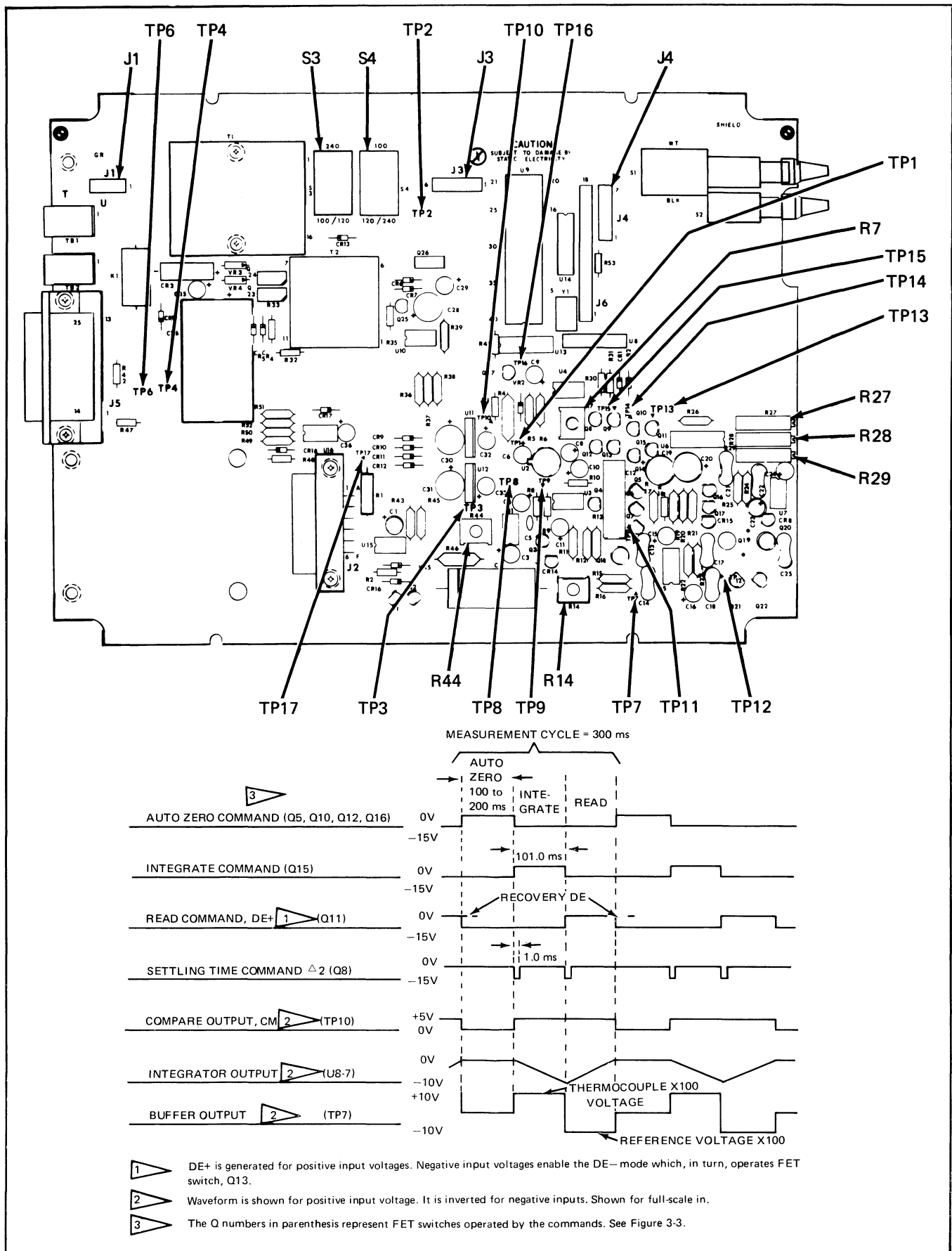


Figure 4-4. Test Points and Measurement Cycle Waveforms

Table 4-5. Test Point Identification

TP1	Analog Common
TP2	Digital Common (–15V) (refer to Analog Common)
TP3	+15V (refer to Analog Common)
TP4	+5V (refer to Analog Common)
TP6	(U9-17) Trigger – S
TP7	Buffer Amp out (U5-1)
TP8	(U2-6)
TP9	Gain Stage out (U3-6)
TP10	Comparator out (U1-7) CM
TP11	Δ 2 Settling Time Command
TP12	INT 1 Integrate Command
TP13	AZ Auto Zero Command
TP14	DE– Read Command (Negative Input)
TP15	DE+ Read Command (Positive Input)
TP16	6.2V (± 100 μ V)
TP17	6.2V (± 100 μ V)

Section 5
List of Replaceable Parts

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Final Assembly, 2180A Digital Thermometer	5-1	5-3	5-1	5-4
A1 Main PCB Assembly	5-2	5-6	5-2	5-10
A2 Display PCB Assembly	5-3	5-11	5-3	5-11
A3 RTD Input PCB Assembly	5-4	5-12	5-4	5-12

5-1. INTRODUCTION

5-2. This section contains an illustrated parts breakdown of the instrument. A similar parts listing for each of the options will be found in Section 6. Components are listed alphanumerically by assembly. Both electrical and mechanical components are listed by reference designation. Each listed part is shown in an accompanying illustration.

5-3. Parts lists include the following information:

1. Reference Designation.
2. Description of each part.
3. FLUKE Stock Number.
4. Federal Supply Code for Manufacturers. (See Section 7 for Code-to-Name list.)
5. Manufacturer's Part Number.
6. Total Quantity per assembly or component.
7. Recommended Quantity: This entry indicates the recommended number of spare parts necessary to support one to five instruments for a period of two years. This list presumes an availability of common electronic parts at the maintenance site. For maintenance for one year or more at an isolated site, it is recommended that at least one of each assembly in the instrument be stocked. In the case of optional subassemblies, plug-ins, etc., that are not

always part of the instrument, or are deviations from the basic instrument model, the REC QTY column lists the recommended quantity of the item in that particular assembly.

5-4. HOW TO OBTAIN PARTS

5-5. Components may be ordered directly from the manufacturer by using the manufacturer's part number, or from the John Fluke Mfg. Co., Inc. factory or authorized representative by using the FLUKE STOCK NUMBER. In the event the part you order has been replaced by a new or improved part, the replacement will be accompanied by an explanatory note and installation instructions if necessary.

5-6. To ensure prompt and efficient handling of your order, include the following information.

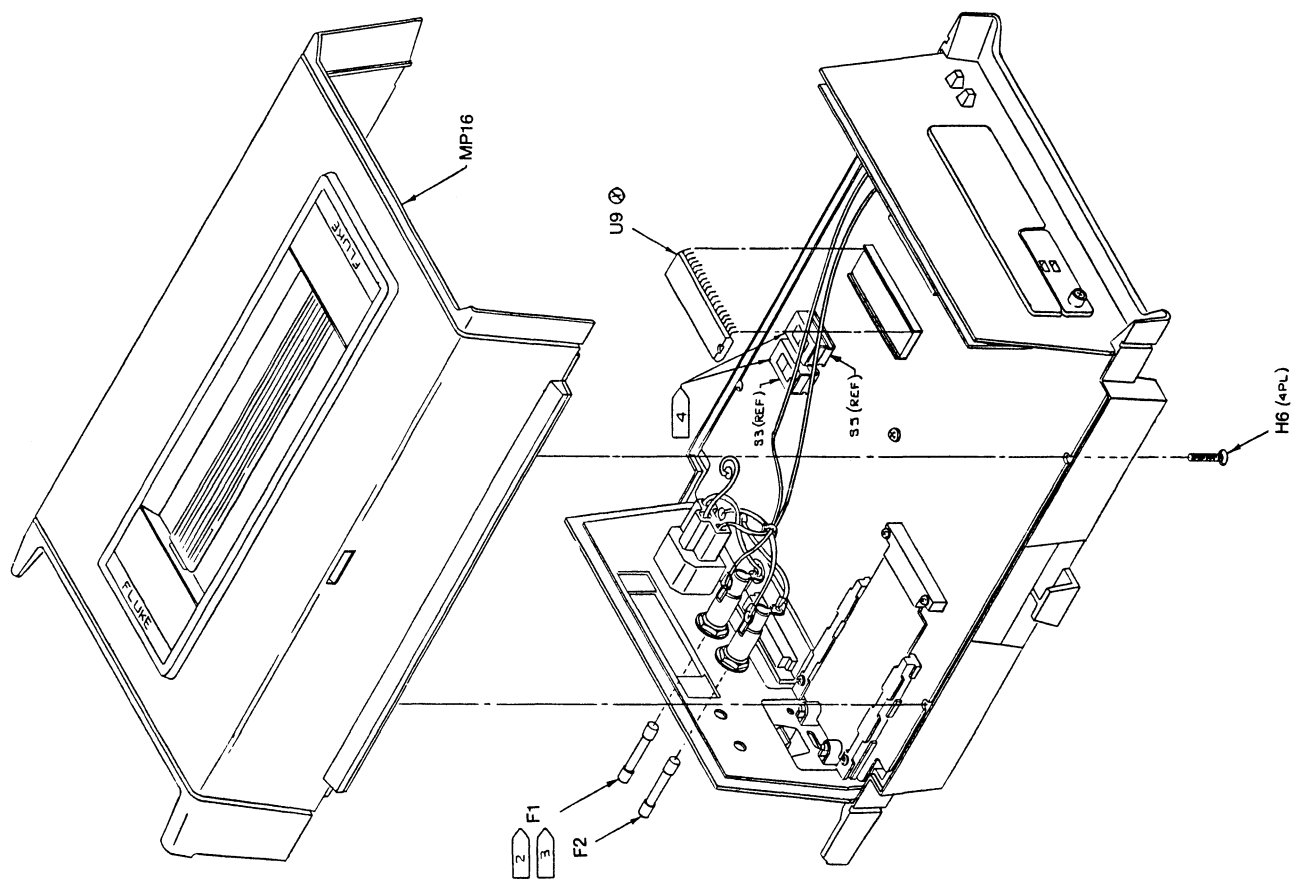
1. Quantity.
2. FLUKE Stock Number.
3. Description.
4. Reference Designation.
5. Printed Circuit Board Part Number.
6. Instrument Model and Serial Number.

* **Indicates MOS devices which may be damaged by static discharge.**

Table 5-1. 2180A Final Assembly
(See Figure 5-1.)

REFERENCE	FLUKE	MFRS	MANUFACTURERS		N
DESIGNATOR	STOCK	SPLY	PART NUMBER	TOT	R O
-A>-NUMERICS-----> S-----DESCRIPTION-----	--NO--	-CODE-	-OR GENERIC TYPE-----	QTY-	-Q -E-
A 1	* MAIN PCB ASSEMBLY	469312	89536 469312	1	
A 2	* DISPLAY PCB ASSEMBLY	489716	89536 489716	1	
A 3	RTD INPUT PCB ASSEMBLY	464305	89536 464305	1	
E 1	TERM, RING 3/32 & 1/8, SOLDR	151431	79963 329	1	
F 1	FUSE, 1/4 X 1-1/4, SLOW, 0.063A, 250V	163030	71400 MDL1-16A		5
F 1	FUSE, 1/4 X 1-1/4, SLOW, 0.125A, 250V	166488	71400 MDL1-8A		1
F 2	FUSE, 1/4 X 1-1/4, SLOW, 0.75A, 250V	109256	71400 MDX3-4	1	5
H 1	SCREW, THD FORM, PHP, STL, 6-20X3/8	288266	89536 288266	1	
H 2	SCREW, MACH, PH, P, SS, 4-40X.250	256156	89536 256156	3	
H 3	SCREW, MACH, PH, P, SS, 4-40X.375	256164	89536 256164	2	
H 4	SCREW, MACH, PHP, BR, 4-40X3/8	493932	89536 493932	1	
H 5	WASHER, LOCK, INTRNL, STEEL, 0.512 ID	641381	89536 641381	2	
H 6	SCREW, MACH, FH, P, STL, 6-32X0.625	114876	89536 114876	4	
MP 1	BASE-STANDARD	454702	89536 454702	1	
MP 2	GUARD, BASE	464404	89536 464404	1	
MP 3	REAR PANEL	464149	89536 464149	1	
MP 4	OUTPUT OPTION COVER	464412	89536 464412		
MP 5	LIMITS COVER	464156	89536 464156		
MP 6	LATCH	467548	89536 467548	2	
MP 7	BAIL	467555	89536 467555	1	
MP 8	FOOT, NONSKID	467571	89536 467571	4	
MP 9	FRONT PANEL WITH HARDWARE	655522	89536 655522	1	
MP 10	CALIBRATION COVER	471490	89536 471490	1	
MP 11	DECAL	454629	89536 454629	1	
MP 12	DECAL, BASE SIDES	473652	89536 473652	2	
MP 13	DECAL, REAR PANEL	454645	89536 454645	1	
MP 14	DECAL, BOTTOM	473637	89536 473637	1	
MP 15	CARD GUIDE	464164	89536 464164	2	
MP 16	"C" SIZE COVER ASSY	516708	89536 516708	1	
MP 17	HLD R PART, FUSE, CAP, 1/4X1-1/4	460238	61935 031.1666	2	
TM 1	2180A INSTRUCTION MANUAL	489211	89536 489211	1	5
U 9	* IC, NMOS, 8 BIT MICROCOMPUTR, 2180A-9402	525659	89536 525659	1	
W 1	CABLE ASSY	475228	89536 475228	1	
W 2	CORD, LINE, 5-15/IEC, 3-18AWG, SVT	343723	89536 343723	1	
XF 1	HLD R PART, FUSE, BODY 1/4X1-1/4, 5X20MM	375188	61935 031.1653	2	

An * in 'S' column indicates a static-sensitive part.



NOTES

1. **WARNING:** Ⓢ INDICATES USAGE OF MOS DEVICES WHICH MAY BE DAMAGED BY STATIC DISCHARGE. USE SPECIAL HANDLING PER S.O.P. 19.1.

2. FOR 100V/120V UNIT OPERATION USE 1/8 AMP FUSE. DISCARD 1/16 AMP FUSE.

3. FOR 240V UNIT OPERATION USE 1/16 AMP FUSE. DISCARD 1/8 AMP FUSE.

4. POSITION S3 Ⓢ S3 FOR DIFFERENT VOLTAGE REQUIREMENTS AS SHOWN:

VOLTAGE	S3	S5
100V	WHT/220	RED/100/220
120V	WHT/220	RED/100/220
220V	RED/220	RED/100/220
240V	RED/220	RED/100/220



2180A T&B
(1 of 2)

Figure 5-1. Final Assembly, 2180A Digital Thermometer

Table 5-3. A2 Display PCB Assembly
(See Figure 5-3.)

REFERENCE			FLUKE	MFRS	MANUFACTURERS		N
DESIGNATOR			STOCK	SPLY	PART NUMBER	TOT	R 0
-A>-NUMERICS----->	S-----	DESCRIPTION-----	--NO--	-CODE-	-OR GENERIC TYPE-----	QTY-	-Q -E-
DS	1- 7	* LED,RED,7 SEGMENT, NUMERIC	418012	28480	5082-7651	7	
Q	1- 13	* TRANSISTOR,SI,PNP,SMALL SIGNAL	195974	64713	2N3906	13	
R	1	RES,CF,100,+5%,0.25W	348771	80031	CR251-4-5P100E	1	
R	3	RES,CF,1,+5%,0.25W	357665	80031	CR251-4-5P1E	1	
U	1	* IC,ARRAY,5 TRANS,NPN,5 ISOLATED TRANS	418574	02735	CA3083E	1	
U	2	RES,NET,DIP,14 PIN,7 RES,1K,+5%	407445	01121	314	1	1
U	3	RES,NET,DIP,16 PIN,8 RES,82,+5%	478859	89536	478859	1	

An * in 'S' column indicates a static-sensitive part.

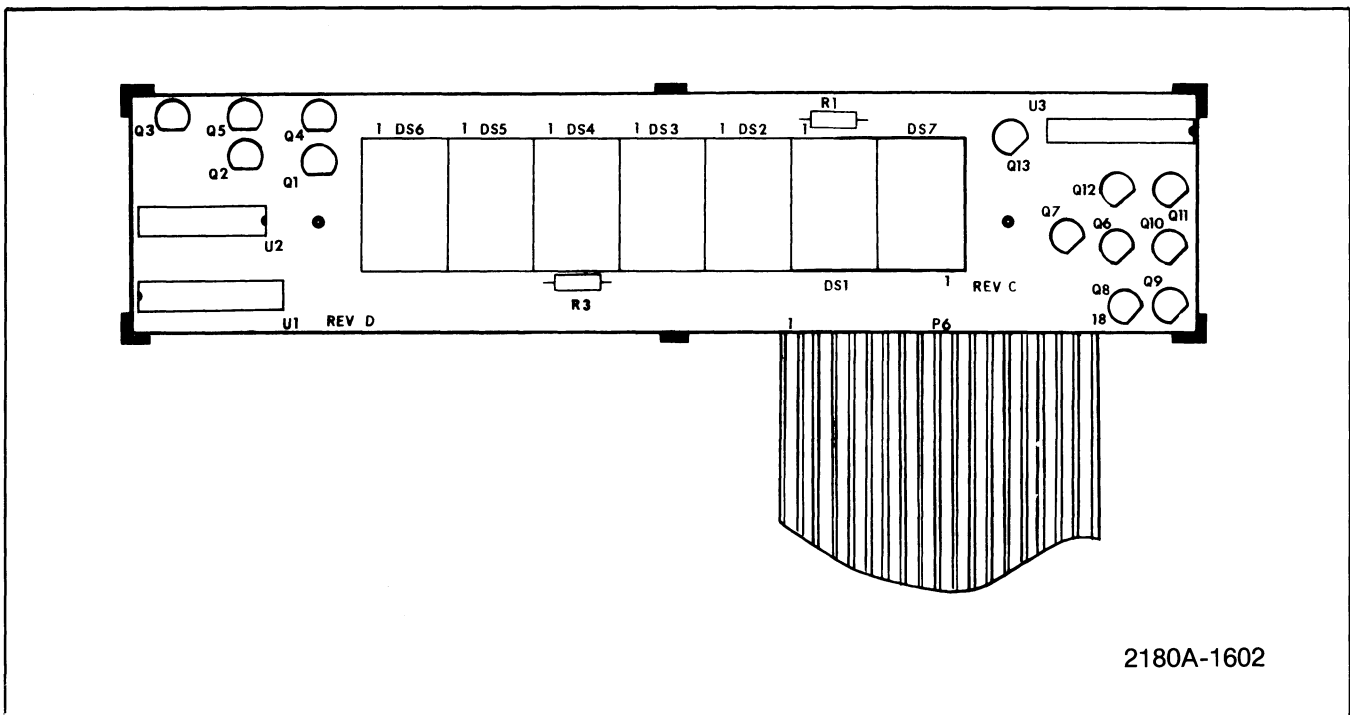
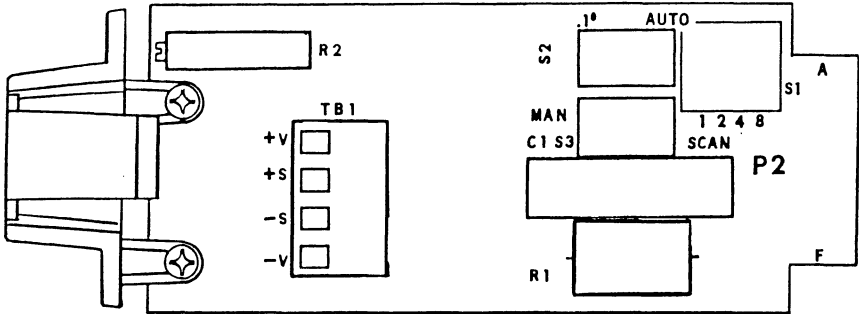


Figure 5-3. A2 Display PCB Assembly

Table 5-4. A3 RTD Input PCB Assembly
(See Figure 5-4.)

REFERENCE DESIGNATOR		DESCRIPTION	FLUKE	MFRS	MANUFACTURERS	TOT	R	N
			STOCK	SPLY	PART NUMBER			
-A>-NUMERICS----->	S-----	DESCRIPTION-----	--NO--	-CODE-	-OR GENERIC TYPE-----	QTY-	-Q-	-E-
C	1	CAP, POLYCA, 2.2UF, +-10%, 100V	306522	73445	C280MCH/A2M2	1		
H	1	NUT, PRESS, BROACH, STL, 4-40	380196	24347	KF2-440	2		
H	1	SCREW, MACH, PH, P, SS, 4-40X.437	403782	89536	403782	2		
H	2	WASHER, LOCK, SPLIT, STEEL, #4	110395	89536	110395	2		
H	3	WASHER, FLAT, FIBER, #4, 0.031 THK	110890	89536	110890	2		
MP	1	INPUT DRAWER	464123	89536	464123	1		
R	1	RES, CC, 47K, +-5%, 1W	150219	01121	CB4735	1		
R	2	RES, VAR, CERM, 500, +-20%, 0.5W	267849	11236	190PC501B	1		
S	1	SWITCH, DIP, SPST, 4 POS	408559	00779	435166-2	1		
S	2,3	SWITCH, PART, SLIDE, BOTTOM, DPDT	454777	10389	24-420-020	2		
S	2,3	SWITCH, PART, SLIDE, TOP, DPDT	454835	10389	24-420-020	2		
TB	1	TERM STRIP, PWB, 45 ANG, 0.200CTR, 4 POS	461475	89536	461475	1		

An * in 'S' column indicates a static-sensitive part.



2180A-1603

Figure 5-4. A3 RTD Input PCB Assembly

Section 6

Option & Accessory Information

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OPTION/ MODEL NO.	DESCRIPTION	PAGE
ACCESSORIES		
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Y2009	Battery Pack, 12V Rechargeable	600-2
Y2022	Divider, Thermometer Calibration	600-2
	Rack Panels	600-2
	Rack Mounts	600-2
Y2024	Power Cord, 3-Way	600-2
Y2026B	Cable Output Unit, RS232C	600-2
OPTIONS		
21X0A-002	Output	602-1
21X0A-004	IEEE-488 Interface	604-1
21X0A-006	Limits	606-1

6-1. INTRODUCTION

6-2. This section of the manual contains information on the accessories and options available for the 2180A Digital Thermometer.

6-3. ACCESSORY INFORMATION

6-4. The portion of this section dealing with accessories contains the details of all accessories available for the 2180A.

6-5. OPTION INFORMATION

6-6. Each of the options available for the 2180A are described separately in a subsection identified with the option name and number. The option description contains the information on the operating instructions and maintenance not covered in the main body of the text, plus a complete list of replaceable parts for the option.

Accessories

600-1. GENERAL

600-2. Table 600-1 contains a list of the accessories available for use with the 2180A Digital Thermometer. The following paragraphs contain information on the types of accessories. Instructions for use accompany each accessory. In all cases order using the accessory number listed.

600-3. RTD MULTIPOINT SELECTOR, (Y2000)

600-4. The Multipoint Selector allows the operator to manually select and monitor the one of up to ten

channels; two separate thermocouple types (maximum of five each if two types used) may be connected to the unit. Up to ten multipoint selectors may be connected in series.

600-5. BATTERY PACK, 12V RECHARGEABLE (Y2009)

600-6. The rechargeable battery pack provides the 2180A and its accessories with portability. The output is +12V dc at a maximum of 750 mA for a total of 2.2 ampere-hours.

Table 600-1. 2180A Accessories

ACCESSORY	DESCRIPTION
Y2000	Multipoint Selector, RTD
Y2009	Battery Pack, 12V Rechargeable
Y2010	Rack Panel PTI, single, A size (for Y2000)
Y2014	Rack Panel PTI, single, C size (for 2180A and Y2002)
Y2015	Rack Panel PTI, double, C size (for 2180A and Y2002)
Y2016	7-inch Rack Adapter PTI, single, D size
Y2017	7-inch Rack Adapter PTI, double, D size
Y2020	Panel Mount PTI-DIN, C size (for 2180A and Y2002)
Y2021	145 mm Panel Mount PTI, D size
Y2022	Divider, Thermometer Calibrator
Y2024	Power Cord, 3-way
Y2026B	Cable, Output Unit, RS-232-C
Y2031	Input Module (for 2180A)
Y2035	Thermal Paper (box of 10)
Y2037	Pt 390 RTD Probe
Y2039	Pt 392 Probe

600-7. DIVIDER, THERMOMETER CALIBRATION (Y2022)

600-8. The device is a preset 100 to 1 divider to provide the precision millivolt outputs from a DC Calibrator required for calibration. The device wires into the RTD Input PCB in place of the RTD Probe during calibration. Refer to the Y2022 Instruction manual for the schematic and additional information.

600-9. RACK PANELS

600-10. Available are rack mounting panels in three sizes and two types for the standard 19-inch electronics equipment racks. The "A" size for the Multipoint Selector is available in panels that will accommodate either one or two instruments. The "B" size panel for the Calibrator and/or Battery Pack is also available for single or double instruments, as is the "C" size used for the 2180A Thermometer and the Alarms Output.

600-11. PANEL MOUNTS

600-12. The panel mounts provide the hardware to install the instrument in any panel in which a hole the size

of the instrument front panel can be cut. It is available for the three instrument sizes required, "A", "B", and "C".

600-13. POWER CORD, 3-WAY (Y2024)

600-14. This accessory is a specially constructed power cord with three female and one male connectors that allow the operator to connect up to "C" size or smaller PTI instruments with one line power cord.

600-15. CABLE OUTPUT UNITS, RS232C (Y2026B)

600-16. The Y2026B is an interface device which allows direct mating between any RS232C device and the -002 Output Option. The Y2026B consists of two 25-pin connectors, one 36-pin connector, and an accessory cable to connection between the 36-pin output and the -002 Output Option. It will be necessary for the user to provide the cable between the 25-pin outputs and the RS232C devices.

Option -002 Output

602-1. INTRODUCTION

602-2. The 21X0-002 Option is an analog and digital output unit. It provides either the 2180A or 2190A Model Digital Thermometers with a recording output for a permanent record when required. The option may be ordered with the unit for factory installation or is available as a kit for installation in the field.

602-3. The analog output is available on the rear panel at two flush banana jacks with the polarity indicated. The output is a scaled voltage source of 1 millivolt per degree of temperature, regardless of the temperature scale selected, with the polarity as read on the display. For example; a reading of 251°F would output +251 mV dc; 97.3°C would output +97.3 mV dc; and -31.9°F would output -31.9 mV dc.

602-4. The digital output is a clocked message that can be in two different formats to match the requirement of the customer's equipment. Output on one set of lines is a bit-parallel, byte-serial message format designed for printer interface. Also available are the standard EIA RS232C and current loop bit-serial outputs. Both formats provide the channel number, the current reading displayed, and any out of range or open thermocouple information.

602-5. SPECIFICATIONS

602-6. Specifications for the Output Option, 21X0-002, are as listed in Table 602-1.

602-7. INSTALLATION

602-8. Options for field installation can be installed using the following procedure:

1. Disconnect the thermometer from all input power sources.

Table 602-1. Specifications

Analog Output
Type: Linearized and isolated.
Voltage: 1.0 mV/ °C or °F from -425 mV to 4.5V, 5 mA max.
Temperature Coefficient: 200 ppm/ °C from 25 °C.
Noise: ≤ 100 uV at 100 Hz bandwidth.
Accuracy: ±0.1% of reading ±1 mV.
Zero Drift: 200 uV/ °C from 25 °C,
Warm-Up Time: 5 minutes, to rated accuracy.
Digital Output
Types: Three, E.I.A. Standard RS-232-C Type 2, TTY current loop, and parallel ASCII.
Connector: 36-pin AMP "Champ".
Serial Baud Rates: 110, 150, 300, 600, 1200, 2400, 4800, 9600, switch-selectable.
RS-232-C Signals: Transmitted Data, Request to Send, Clear to Send, Data Set Ready, Signal Common.
Parallel ASCII Signals: Data 8 lines, instrument address 3 lines, Address Valid, Data Valid, Acknowledge, ground, +5V.
Parallel ASCII Data Rate: Three readings per second.
Parallel ASCII Interface: Plug-to-plug compatible with similar Fluke equipment. CMOS compatible, drives one TTL load.
TTY Current Loop Signals: Source and controlled sink, 20 mA.
Out-of-Limit Signal: Exclamation point transmitted with Option 21X0-006 only; not with Y2002.
Battery Operation: 4 to 5 hours typical at 25 °C on fully charged Y2003 or Y2009.

2. Remove the screws on the bottom of the case that fasten the top and bottom of the PTI case together and remove the top half of the case.
3. Remove the center mounting screw that attaches the Main PCB to the case and lift the pcb clear of the case.
4. Attach the four spacers supplied with the option to the component side of the pcb in the holes forming a rough rectangular pattern (do not use the fifth hole on the corner, next to U1).

Table 602-2. Switch Selection

SWITCH POSITION	SWITCH BANK				S1 BAUD RATE	S2 FUNCTION	S3 ADDRESS
	1	2	3	4			
0	OFF	OFF	OFF	OFF	110	OPERATE	ADR 0
1	ON	OFF	OFF	OFF	150	CAL 1	ADR 1
2	OFF	ON	OFF	OFF	300	CAL 2	ADR 2
3	ON	ON	OFF	OFF	600	CAL 3	ADR 3
4	OFF	OFF	ON	OFF	1200	CAL 4	ADR 4
5	ON	OFF	ON	OFF	2400	CAL 1	ADR 5
6	OFF	ON	ON	OFF	4800	CAL 2	ADR 6
7	ON	ON	ON	OFF	9600	CAL 3	ADR 7
8	OFF	OFF	OFF	ON	110	PLOT 1	ADR 8
9	ON	OFF	OFF	ON	150	PLOT 2	ADR 9

5. Reinstall the Main PCB in the bottom half of the case.

6. On the Output Unit PCB use Table 602-2 and S1 to select the desired BAUD rate, select position 0 on the Function switch S2, and select the PTI Bus Address using S3. When using the RS-232-C interface, set the address switch S3 to address 1, 6, 7, 8, or 9. When using the 2XXXA-522 Personality Card and the 1120A IEEE-488 Translator, set the baud rate to 2400 and follow all procedures regarding the RS-232-C interface.

7. Connect the Output Unit cables to the connectors on the Main PCB.

8. Attach the Output Unit PCB to the spacers, component side down, and the connector to the rear panel access port.

9. Replace the PTI cover on the instrument and reconnect the input power sources, if required, at this time.

Table 602-3. Digital Output Connector Pin-Out

PIN NO.	FUNCTION	MNEMONIC	USE
1	Address Valid	ADRVAL	PTI Bus
2	Data Valid	DATVAL	PTI Bus
3-6	Printer Address	A0-A3	PTI Bus
7	Acknowledge	ACK	PTI Bus
8	Not Used		
9-16	Data	D0-D7	PTI Bus
17	Ground		PTI Bus
18	+5 Volts		PTI Bus
19-24	Not Used		
30	Transmitted Data		RS232 Interface
31	Request to send		RS232 Interface
32	Clear to send		RS232 Interface
33	Data set ready		RS232 Interface
34	Signal Common		RS232 Interface
35	S0+		Current Loop
36	S0-		Current Loop

602-9. OUTPUT CONNECTIONS

602-10. All connections between the Output Unit Option and external instruments are made using the rear panel connectors previously described. The analog output is from standard banana jacks. The digital output female connector has a mating male connector accompanying the option. This allows the customer to custom make a cable between the thermometer output option and the receiving device. Table 602-3, is the pin-out data for the digital output connector.

NOTE

Standard RS232C signals are output on 25-pins, the connector on the -002 Output Option is 36-pins, therefore, the user must either hardwire the connection between the -002 Output Option or order the Y2026B, Cable Adapter.

602-11. OPERATION

NOTE

For RS232C or 20 mA current loop operation, the -002 address switches may be ignored.

The Data Set Ready (DSR, pin 33) or Clear To Send (CTS, pin 32) must be at +3V to +15V in order to output data on the RS232C bus. These lines can be tied to Request To Send (RTS, pin 31) which provides the required +15V.

602-12. Once the Output Unit Option is installed, the only operator functions deal with the connection of external equipment to the analog or digital output connectors.

602-13. The positive and negative analog terminals have available a dc millivolt output with the same polarity, and proportional to the temperature displayed. For example, if the thermometer displayed +105.7°F the analog output would be +105.7 mV dc and for -53.1°C the output would be -53.1 mV dc. The full resolution of the temperature display (tenths or hundredths of degrees) is reflected on the output.

602-14. The digital output can be connected to a printer or any device accepting parallel ASCII data, or to a device accepting RS232C or Current Loop signals. Connections for all three types of signals are available simultaneously on the 36-pin output connector previously described.

602-15. THEORY OF OPERATION

602-16. The Output Unit Option converts the temperature displayed by the output into a format usable by the customer's equipment. The output may be available as a scaled analog voltage or as formatted parallel and serial ASCII digital output. The following paragraphs describe operation of the Accessory Bus that handles communication between the instrument and the options, the analog output circuitry and the digital output circuitry. Refer to the schematic in Section 8 during the following discussion.

602-17. Accessory Bus Communication

602-18. The option communicates with the thermometer on the clocked bit-serial accessory bus. Transmitted on the bus are channel number, range, conversion type, scale, and digits of the temperature reading. When the WRTADR line is held low, DCLK clocks the address of the Output Unit (4), followed by the thermometer data to the microprocessor on the DATA

line. Once into the microprocessor, the data is converted, formatted, and output to the analog and digital output circuitry.

602-19. Analog Circuitry

602-20. The temperature reading received by the microcomputer is used to generate an integrate control signal, the length of which is proportional to the magnitude of the temperature reading. This signal is used to turn on (close) the FET switches Q6 and U12-2, open the switches U11-2, U11-3 and U12-3, and set the output polarity with switches at U12-9 and U12-10. (U12-9 is closed when a negative reading is being processed and U12-10 when a positive signal is being processed.)

602-21. With Q6 on, the capacitor C1 is charged linearly to a voltage proportional to the length of the control signal at Q6. When Q6 has been on for the time required, it is opened, and switch U11-13 is closed, so the output of U13-8 can be sampled and held on C2. After 10 ms switch U11-3 opens and switch U11-11 closes to zero the integrate capacitor C1, until the next conversion cycle.

602-22. The voltage held on C2 is buffered by U13-7. U13-14 either passes the voltage directly to the output stage, or amplifies it as controlled by switches U12-9 and U12-10, which alternate states to set the polarity. The output stage at U13-1 has a constant gain of -1.

602-23. Digital Output Circuitry

602-24. The thermometer reading transmitted on the accessory bus every 333 ms is formatted by the microcomputer and, if requested, made available on the PTI Bus, RS232C, and current loop outputs. Refer to the schematics in Section 8 during the following description.

602-25. Eight data, four address, a data valid, an address valid, and an acknowledge line are used by the PTI Bus Interface. The external device requests data from the Output Unit by applying the preselected address to the address lines. The address is preselected by setting switch S3 to the desired number (0-9). When the proper address is decoded the tri-state output buffers (U8 and U9) are enabled, and the microcomputer and external device are notified that the Output Unit has a valid address. When the conversion process is complete, the microcomputer applies the first character of the formatted data to the output lines and pulls the DATVAL line low. The external device reads the data and pulls the ACK line low, causing the Output Unit to reply with a new character. The process is repeated until data transfer is complete. The message formats are shown in Figure 602-1, and a timing diagram is shown in Figure 602-2.

602-26. After transfer to the printer lines is complete, the microcomputer checks the DATA SET READY and CLEAR TO SEND lines from the RS232C Interface. If both lines are high, the same message as was output on the print lines is output on the RS232C and current loop lines in a bit-serial format. Since the thermometer cycle rate of 333 ms is shorter than the time required to output data at BAUD rate of 1200 and less, a message is not transmitted during every instrument cycle.

602-27. CALIBRATION

602-28. Analog circuitry in the option should be calibrated every 90 days or after any repair of the unit. The procedure following assumes that power is supplied to the unit and that a Digital Voltmeter capable of reading 10 μ V on the 1 volt, or equivalent range, i.e., a Fluke Model 8800A, is available.

1. Remove power from the instrument.
2. Remove the top cover from the thermometer.
3. Remove the screws attaching the option pcb to the Main PCB.
4. Leaving the interconnect cables connected, turn the option pcb to the right, while facing the instrument, exposing the component side and making the switches and adjustment accessible.
5. Connect the DMM to the Analog Output Connector.
6. Apply power to the instrument and allow it to warm-up for a minimum of 5 minutes.

7. Set the FUNCTION switch (S2) to position 1 (CAL 1).
8. Adjust R26 for an output of 0 ± 0.1 mV dc.
9. Set the FUNCTION switch to position 2 (CAL 2).
10. Adjust R15 for an output of 0 ± 0.1 mV dc.
11. Set FUNCTION switch to position 3 (CAL 3).
12. Adjust R11 for an output of $-10V \pm 1$ mV dc.
13. Set FUNCTION switch to position 4 (CAL 4).
14. Adjust R19 for an output of $+10V \pm 1$ mV dc.
15. Remove power and the test DMM, then reinstall the option pcb on the Main PCB and the top cover on the instrument.

602-29. TROUBLESHOOTING

602-30. Troubleshooting for the 2180A Option -002, Output Unit, consists of the tabular flow chart in Table 602-4. When a step on the flow chart is completed, check for a decision transfer. If no decision is required, perform the next step of the table in sequence.

602-31. LIST OF REPLACEABLE PARTS

602-32. Table 602-5 is a list of replaceable parts for the Output Option. Refer to Section 5 for an explanation of the columnar entries.

CHARACTER POSITION																				
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
NORMAL TEMPERATURE MEASUREMENT DATA																				
CH	CH	SP	SP	±	SP	D	D	D	D/.	D/.	D	SP	SP	F/C	SP	!	SP	SP	CR	LF
OPEN THERMOCOUPLE OUTPUT (2190A only)																				
CH	CH	SP	SP	±	SP	D	D	D	D/.	D/.	D	SP	SP	F/C	SP	!	O	C	CR	LF
OVERLOAD OUTPUT																				
CH	CH	SP	SP	±	SP	D	D	D	D/.	D/.	D	SP	SP	F/C	SP	!	O	L	CR	LF

SYMBOL	DESCRIPTION
CH	Channel identification numbers (00 through 99, 00 unless connected to Y2000, Y2001, or 2300A).
SP	Space
+/-	Plus or minus symbol
D	Temperature data values (0 through 9) Floating decimal point, appearing in character positions 11 or 12 for the 2180A, position 12 for the 2190A.
D/.	Either a temperature data value or a decimal point
F/C	Fahrenheit or Celsius
!	Character (!) when the present limit of the Limits Option 21X0A-006 is exceeded. One space if within limits.
OC	Open (thermo)couple (character positions 18 and 19)
OL	Overload (character positions 18 and 19)
CR	Carriage Return
LF	Line Feed

Figure 602-1. Message Format

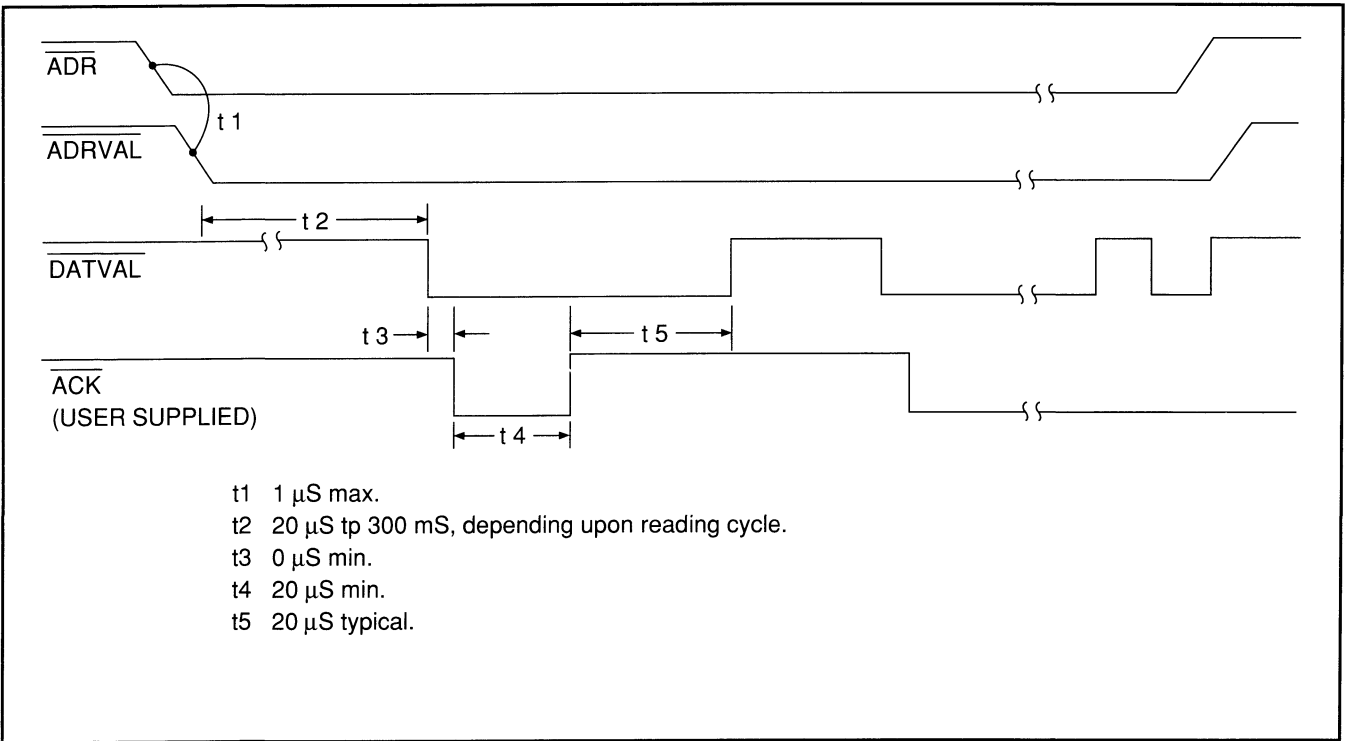


Figure 602-2. Timing Diagram

Table 602-5. Option -002 Output PCB Assembly
(See Figure 602-3.)

REFERENCE DESIGNATOR	FLUKE STOCK	MFRS SPLY	MANUFACTURERS PART NUMBER	TOT	R S	O T
-A>-NUMERICS--> S-----DESCRIPTION-----	--NO--	-CODE-	-OR GENERIC TYPE-----	QTY-	-Q-	-E-
A 1	* OUTPUT UNIT ADAPTER ASSEMBLY	539288	89536 539288	1		
C 1	CAP,POLYPR,0.47UF,+/-5%,100V	806265	89536 806265	1		
C 2	CAP,POLYPR,0.47UF,+/-10%,50V	363085	89536 363085	1		
C 3	CAP,CER,0.22UF,+/-20%,50V,Z5U	309849	71590 CW3COC224K	1		
C 4, 6, 9-	CAP,TA,10UF,+/-20%,20V	330662	56289 196D106X0020KA1	8		
C 11, 13- 15		330662				
C 5	CAP,TA,39UF,+/-20%,20V	358234	56289 196D396X0020PE4	1		
C 7, 8	CAP,TA,22UF,+/-20%,35V	394775	56289 196D226X0035TE4	2		
C 12, 16	CAP,TA,1UF,+/-10%,35V	161919	56289 196D010X0035G	2	1	
C 17	CAP,CER,0.025UF,+/-20%,100V,Z5W	168435	56289 CO23B101H253M	1	1	
CR 3- 6, 11-	* DIODE,SI,BV=75V,IO=150MA,500MW	203323	07910 1N4448	10	1	
CR 14, 16, 17		203323				
CR 9, 10	* DIODE,SI,50 PIV,1.0 AMP	379412	04713 1N4933	2	1	
H 1	HARDWARE KIT (FOR J7)	435750	89536 435750	1		
H 2	WASHER,LOCK,SPLIT,STEEL,#4	110395	89536 110395	2		
H 3	NUT,HEX,S.STL,4-40	147611	89536 147611	2		
H 4	SCREW,MACH,PH,P,4-40X0.375	837690	89536 837690	2		
J 7	CONN,MICRO-RIBBON,REC,PWB EDGE,36 POS	414409	00779 552241-1	1		
J 8	INPUT JACK,FLARED	492314	89536 492314	2		
P 1	CABLE,FLAT,JMPR,4 CONDUCT,0.100 SP	474148	89536 474148	1		
P 3	CABLE,FLAT,JMPR,6 CONDUCT,0.100 SP	474155	00779 86942-5	1		
Q 2, 4, 5,	* TRANSISTOR,SI,NPN,SMALL SIGNAL	218396	04713 2N3904	6		
Q 8, 9, 13		218396				
Q 6	* TRANSISTOR,SI,N-JFET,REMOTE CUTOFF	429977	89536 429977	1	1	
Q 7	* TRANSISTOR,SI,N-JFET,TO-92	343830	12040 NSSF50024	1	1	
Q 10, 11	* TRANSISTOR,SI,BV= 80V, 10W,TO-202	495697	04713 MPS-U06	2	1	
Q 12	* TRANSISTOR,SI,BV= 40V, 2W,TO-220	473207	01295 TIP30	1		
Q 14	* TRANSISTOR,SI,PNP,SMALL SIGNAL	195974	64713 2N3906	1		
R 1- 3, 27-	RES,CF,10K,+/-5%,0.25W	348839	80031 CR251-4-5P10K	12		
R 30, 32- 34,		348839				
R 48, 50		348839				
R 4, 6, 8	RES,CF,220K,+/-5%,0.25W	348953	80031 CR251-4-5P220K	3		
R 5, 7, 9,	RES,CF,2.2K,+/-5%,0.25W	343400	80031 CR251-4-5P2K2	4		
R 31		343400				
R 10	RES,MF,16.9K,+/-1%,0.125W,100PPM	267146	91637 CMF551692F	1		
R 11	RES,VAR,CERM,25K,+/-20%,0.5W	285213	11236 190PC253B	1		
R 12	RES,MF,124K,+/-1%,0.125W,25PPM	479352	91637 CMF55	1		
R 13	RES,MF,2K,+/-1%,0.125W,100PPM	235226	91637 CMF552001F	1		
R 14	RES,MF,750K,+/-1%,0.125W,100PPM	271361	89536 271361	1	1	
R 15, 26	RES,VAR,CERM,100K,+/-20%,0.5W	268581	71450 190PC104B	2		
R 16, 17	RES,MF,60.4K,+/-1%,0.125W,100PPM	291419	91637 CMF556042F	2		
R 18, 20	RES,MF,3.92K,+/-1%,0.125W,100PPM	294801	91637 CMF553921F	2		
R 19	RES,VAR,CERM,100,+/-10%,0.5W	285130	89536 285130	1		
R 21, 22, 45	RES,MF,10K,+/-1%,0.125W,100PPM	168260	91637 CMF551002F	3		
R 23, 47	RES,CF,100,+/-5%,0.25W	348771	80031 CR251-4-5P100E	2		
R 24	RES,MF,1M,+/-1%,0.125W,100PPM	268797	91637 CMF551004F	1		
R 25	RES,MF,1K,+/-1%,0.125W,100PPM	168229	91637 CMF551001F	1		
R 35	RES,CF,5.1K,+/-5%,0.25W	368712	80031 CR251-4-5P5K1	1		
R 36	RES,CF,47K,+/-5%,0.25W	348896	80031 CR251-4-5P47K	1		
R 37	RES,CF,240,+/-5%,0.25W	376624	80031 CR251-4-5P240E	1		
R 38	RES,CF,3.9K,+/-5%,0.25W	342600	80031 CR251-4-5P3K9	1		
R 39, 41	RES,CF,6.8K,+/-5%,0.25W	368761	80031 CR251-4-5P6K8	2		
R 40	RES,CF,4.3K,+/-5%,0.25W	441576	80031 CR251-4-5P4K3	1		
R 42	RES,CF,3.3K,+/-5%,0.25W	348813	80031 CR251-4-5P3K3	1		
R 43	RES,CF,330,+/-5%,0.25W	368720	80031 CR251-4-5P330E	1		
R 44	RES,MF,1.02K,+/-1%,0.125W,100PPM	223545	91637 CMF551021F	1		
R 46	RES,MF,9.09K,+/-1%,0.125W,100PPM	221663	91637 CMF559091F	1		
R 49	RES,MF,4.32K,+/-1%,0.125W,100PPM	294819	91637 CMF554321F	1		
R 51	RES,CF,39K,+/-5%,0.25W	442400	80031 CR251-4-5P39K	1		
R 52	RES,MF,100K,+/-1%,0.125W,100PPM	248807	91637 CMF551003F	1		
R 53	RES,MF,64.9K,+/-1%,0.125W,100PPM	288530	91637 CMF556493F	1	2	
R 54	RES,MF,226K,+/-1%,0.125W,100PPM	320879	91637 CMF552263F	1		
R 55	RES,MF,309K,+/-1%,0.125W,100PPM	235283	91637 CMF553093F	1		
S 1- 3	SWITCH,DIP,SPST,4 POS	408559	00779 435166-2	3		
T 1	TRANSF,INV,MULTIPLE OUTPUT,TOROID	461954	89536 461954	1		
U 1	* IC,CMOS,HEX BUFFER	381830	02735 CD4050AE	1	1	
U 2- 4	* ISOLATOR,OPTO,LED TO TRANSISTOR	536045	14936 MCT-26	3	1	
U 5	RES,NET,SIP,8 PIN,7 RES,47K,+/-2%	413286	89536 413286	1		
U 6	* IC,CMOS,HEX OPEN DRAIN BUFFER	473389	12040 MM74C906N	1	1	

An * in 'S' column indicates a static-sensitive part.

Table 602-5. Option -002 Output PCB Assembly (cont)

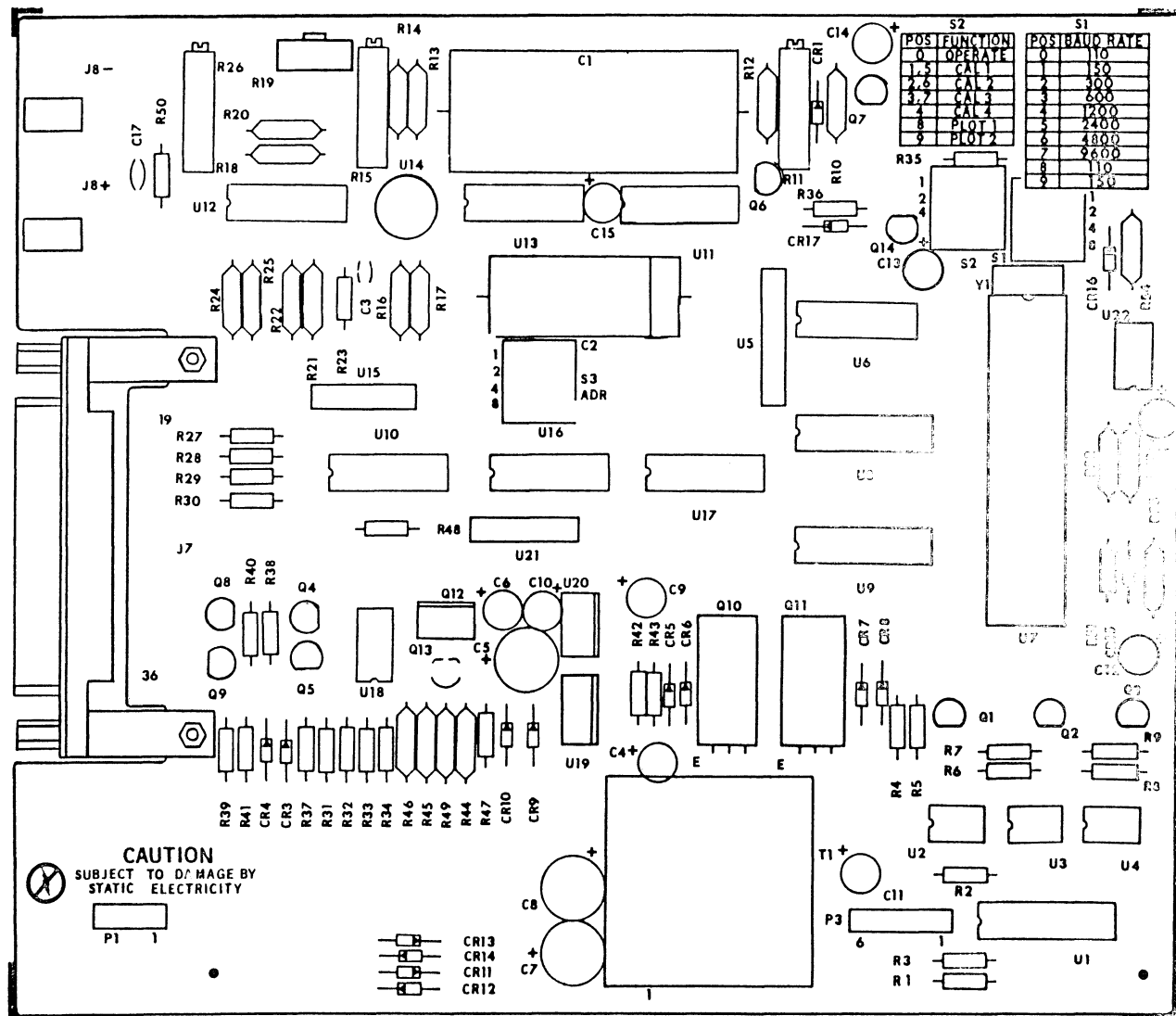
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-A>-NUMERICS----->	S-----	DESCRIPTION-----	--NO--	-CODE-	-OR GENERIC TYPE-----	QTY-	-Q-	-E-
U 7		* IC,NMOS,8 BIT MICROCOMPUTR,2190A-9403	495309	89536	495309	1		
U 8, 9		* IC,CMOS,HEX BUFFER W/3-STATE OUTPUT	407759	12040	MM80C97N	2	1	
U 10		* IC,CMOS,HEX INVERTER	404681	02735	CD4069BE	1	1	
U 11, 12		* IC,CMOS,QUAD BILATERAL SWITCH	363838	02735	CD4016AE	2	1	
U 13		* IC,OP AMP,QUAD,JFET INPUT,14 PIN DIP	483438	89536	483438	1	1	
U 14		* TRANSISTOR,SI,N-JFET,DUAL,TO-71	419283	89536	419283	1	1	
U 15, 21		RES,NET,SIP,6 PIN,5 RES,100K,+/-2%	412726	89536	412726	2		
U 16		* IC,CMOS,QUAD XOR GATE	355222	02735	CD4030AE	1	1	
U 17		* IC,CMOS,DUAL 4 INPUT NOR GATE	363820	02735	CD4002AE	1	1	
U 18		* IC,OP AMP,DUAL,JFET INPUT,8 PIN DIP	454454	02735	CA082E	1	1	
U 19		* IC,VOLT REG,FIXED,+15 VOLTS,1.5 AMPS	413187	04713	MC7815CT	1	1	
U 20		* IC,VOLT REG,FIXED,-15 VOLTS,1.5 AMPS	413179	04713	MC7915CP	1	1	
U 22		* IC,COMPARATOR,DUAL,LO-PWR,8 PIN DIP	478354	12040	LM393N	1	1	
VR 1		* ZENER,COMP, 6.4V, 2%, 2 PPM TC, 0.5MA	393579	04713	1N4567	1		
VR 7, 8		* ZENER,UNCOMP,36.0V,5%,3.4MA,0.4W	186163	04713	1N974B	2	2	
VR 15		* ZENER,UNCOMP,6.2V,5%,20.0MA,0.4W	325811	07910	1N753A	1	1	
X 1		SOCKET,IC,40 PIN	429282	09922	DILB40P-108	1		
Y 1		* CRYSTAL,4MHZ,+/-0.02%,HC-18/U	474072	89536	474072	1	1	

An * in 'S' column indicates a static-sensitive part.

Table 602-6. A1 Output Unit Adapter PCB Assembly
(See Figure 602-4.)

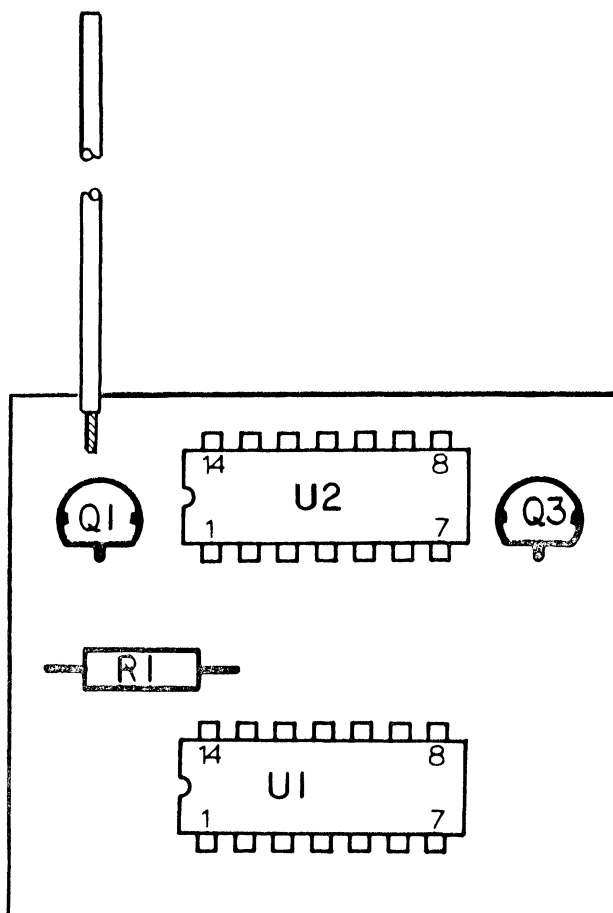
REFERENCE DESIGNATOR			FLUKE STOCK	MFRS SPLY	MANUFACTURERS PART NUMBER	TOT	R S	N O T
-A>-NUMERICS----->	S-----	DESCRIPTION-----	--NO--	-CODE-	-OR GENERIC TYPE-----	QTY-	-Q-	-E-
J 1- 6		PIN,SINGLE,PWB,0.025 SQ	376574	89536	376574	6		
Q 1, 3		* TRANSISTOR,SI,NPN,SMALL SIGNAL	218396	89536	218396	2		
R 1		RES,CF,10K,+/-5%,0.25W	348839	89536	348839	1		
U 1		* IC,CMOS,DUAL D F/F,+EDG TRIG	340117	89536	340117	1		
U 2		* IC,CMOS,HEX INVERTER	404681	89536	404681	1		

An * in 'S' column indicates a static-sensitive part.



2180A-1620

Figure 602-3. Option -002 Output PCB Assembly



2180A-1621

Figure 602-4. Output Unit Adapter Assembly

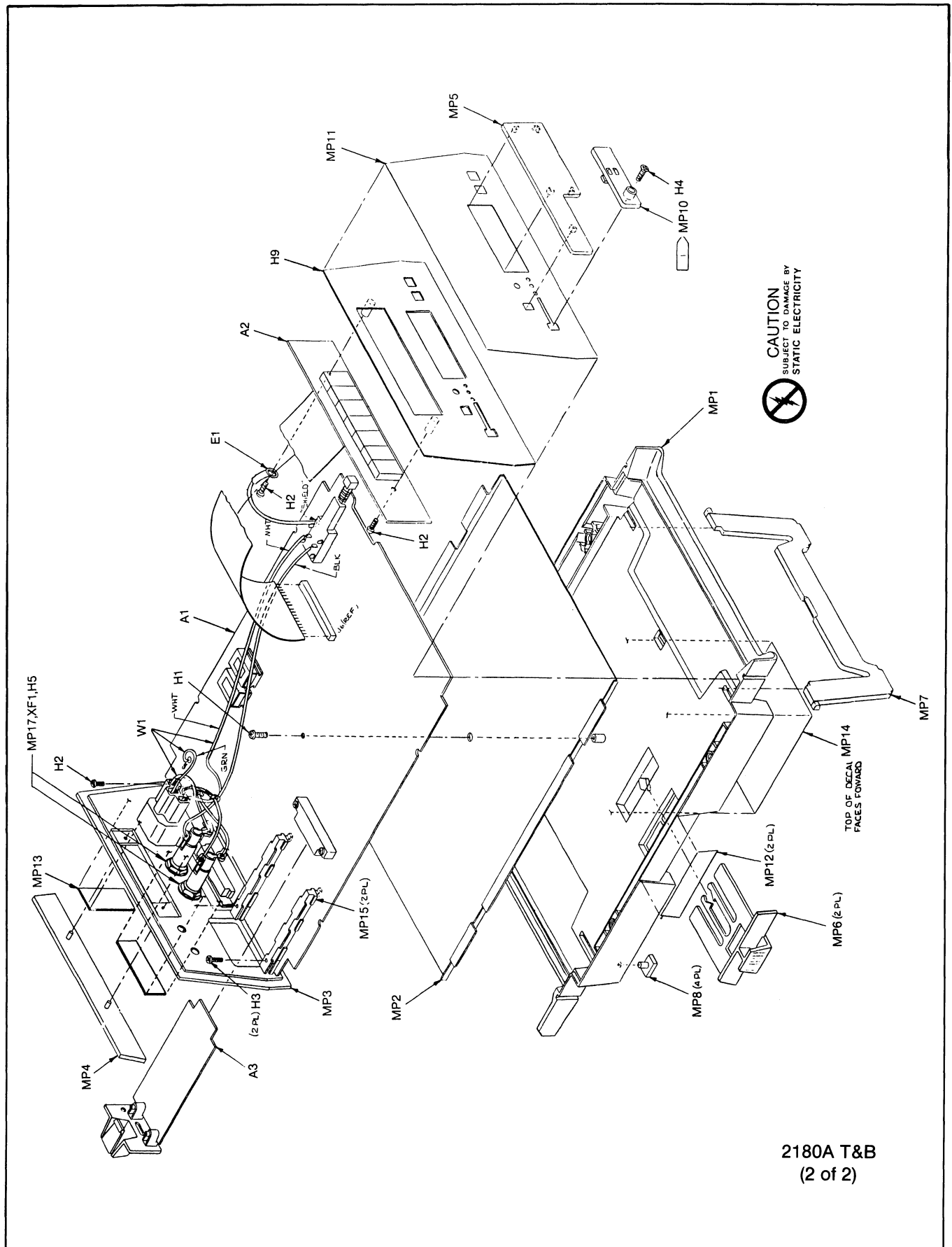


Figure 5-1. Final Assembly, 2180A Digital Thermometer (cont)

Table 5-2. A1 Main PCB Assembly
(See Figure 5-2.)

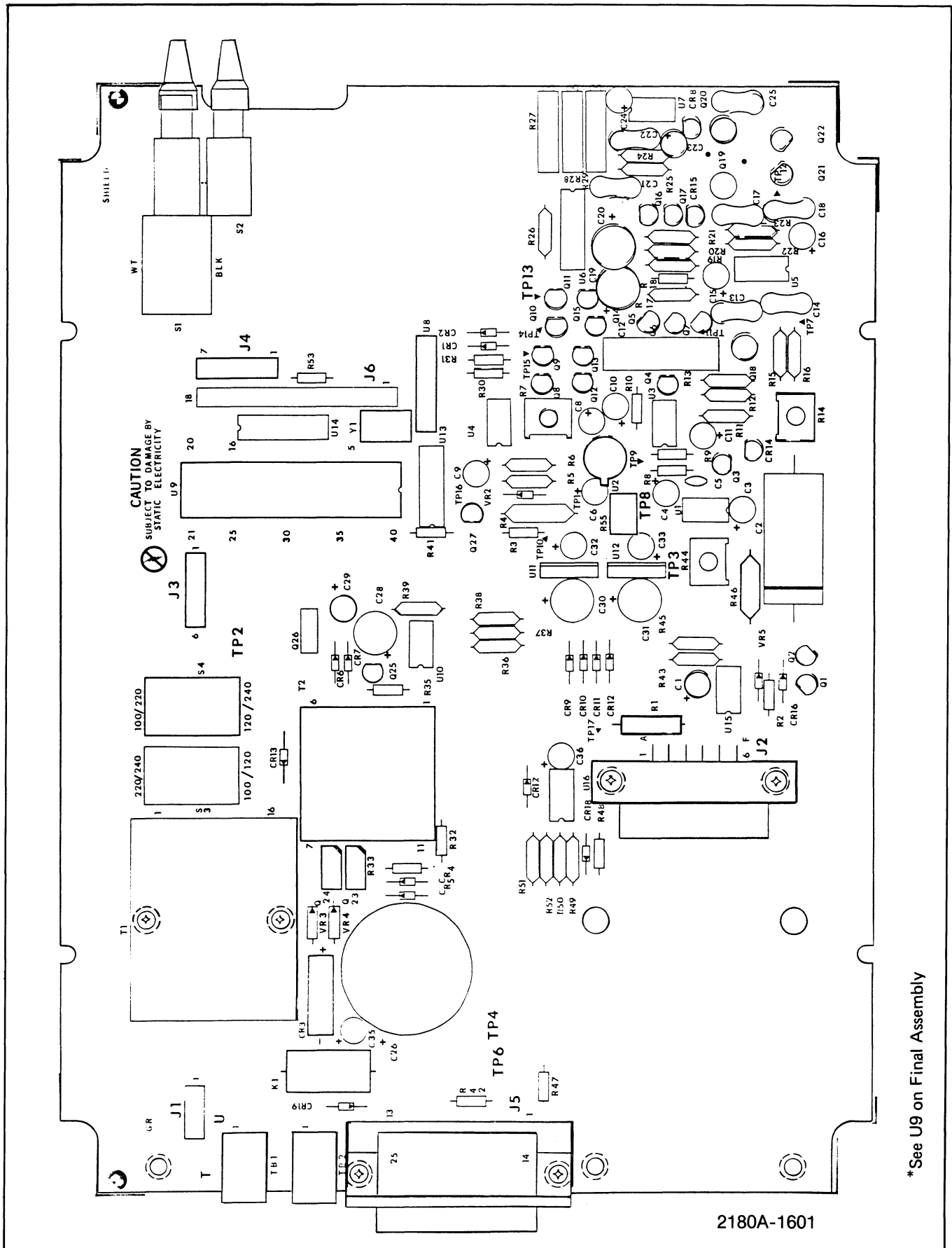
REFERENCE DESIGNATOR	FLUKE STOCK	MFRS SPLY	MANUFACTURERS PART NUMBER	TOT	R S	O T		
-A>-NUMERICS-----	S-----	DESCRIPTION-----	--NO--	-CODE-	-OR GENERIC TYPE-----	QTY-	-Q	-E-
C 1, 3, 4,		CAP,TA,10UF,+-20%,20V	330662	56289	196D106X0020KA1	16		
C 6, 8- 11,			330662					
C 15, 16, 23,			330662					
C 24, 29, 32,			330662					
C 33, 35			330662					
C 2		CAP,POLYPR,0.47UF,+-5%,50V,HERMETIC	364042	84411	JF788	1		
C 5		CAP,CER,0.0012UF,+-10%,500V,Z5R	106732	71590	CF122	1		
C 12		CAP,POLYCA,2.2UF,+-10%,100V	306522	73445	C280MCH/A2M2	1		
C 13, 14, 17,		CAP,MICA,430PF,+-5%,500V	177980	14655	CD15FD431J0	6		
C 18, 21, 22			177980					
C 19, 20		CAP,TA,10UF,+-20%,35V	417683	56289	196D106X0035KA1	2		
C 25		CAP,MICA,5PF,+-0.5PF,500V	148577	89536	148577	1		
C 26		CAP,AL,4700UF,+-75-20%,25V	614115	89536	614115	1		
C 28		CAP,TA,39UF,+-20%,20V	358234	56289	196D396X0020PE4	1		
C 30, 31		CAP,TA,22UF,+-20%,35V	394775	56289	196D226X0035TE4	2	1	
C 36		CAP,TA,1UF,+-10%,35V	161919	56289	196D010X00035G	1		
CR 1, 2, 4, *		DIODE,SI,BV=75V,IO=150MA,500MW	203323	07910	1N4448	10	1	
CR 5, 9- 12, *			203323					
CR 17, 19			203323					
CR 3		* DIODE,SI,RECT,BRIDGE,BV=100V,IO=1.0A	392910	09423	FB200	1	1	
CR 6, 7		* DIODE,SI,50 PIV,1.0 AMP	379412	04713	1N4933	2		
CR 8, 14, 15		* DIODE,SI,N-JFET,CURRENT REG,IF=1.0 MA	348482	89536	348482	3	1	
CR 13		* DIODE,SI,100 PIV,1.5 AMP	116111	05277	1N4817	1	2	
CR 16		* DIODE,SI,2 PELLET,BV= 20.0V,400 MW	375477	09214	MPD200	1	1	
H 2		INSERT,STUD,BROACHING,PHOSPHOR BRONZE	493833	89536	493833	4		
H 3		SCREW,MACH,PH,P,,4-40X0.375	837690	89536	837690	2		
H 4		WASHER,FLAT,BRASS,#4;0.025	110775	89536	110775	2		
H 5		SCREW,MACH,PH,P,STL,4-40X1.500	156380	73734	19032	2		
H 6		SCREW,MACH,SEMS,PH,P,STL,4-40X.500	353060	89536	353060	2		
H 7		WASHER,LOCK,SPLIT,STEEL,#4	110395	89536	110395	1		
J 1		SOCKET,1 ROW,PWB,0.100CTR,4 POS	461756	00779	583773-1	1		
J 2		CONN,PWB EDGE,REC,90,0.156CTR,12 POS	474007	05574	2VH6/1AKC15	1		
J 3		SOCKET,1 ROW,PWB,0.100CTR,6 POS	448209	00779	1-583773-3	1		
J 4		SOCKET,1 ROW,PWB,0.100CTR,7 POS	484030	00779	1-583773-4	1		
J 5		CONN D-SUB,PWB,RT ANGL,25 SCKT,.590	461996	00779	206584-1	1		
J 6		SOCKET,1ROW,PWB,0.100CTR,18POS	435024	00779	583773-8	1		
K 1		RELAY,REED,1 FORM A,4.5VDC	357582	71707	UF40070	1		
MP 1		NUT,PRESS,BROACH,STL,4-40	380196	24347	KF2-440	9		
MP 2		CABLE TIE,5-1/2"L,0.100"W,1.25 DIA	530360	89536	530360	1		
MP 3		HEAT,DIS,CLIP,TO-220	428805	13103	6046P8	1		
MP 4		BUTTON,MODIFIED,GREEN	644435	89536	644435	1		
MP 5		BUTTON,MODIFIED,LT. GRAY	540724	89536	540724	1		
Q 1, 2, 9, *		TRANSISTOR,SI,N-JFET,TO-92	343830	12040	NSSF50024	9	1	
Q 12- 15, 17, *			343830					
Q 22			343830					
Q 3, 25, 27		* TRANSISTOR,SI,NPN,SMALL SIGNAL	218396	04713	2N3904	3	2	
Q 4, 6- 8, *		* TRANSISTOR,SI,N-JFET,TO-92	376475	15818	U2810J	8	1	
Q 10, 11, 16, *			376475					
Q 21			376475					
Q 5		* TRANSISTOR,SI,N-JFET,REMOTE CUTOFF	429977	89536	429977	1	1	
Q 18		* TRANSISTOR,SI,N-JFET,DUAL,TO-71	419283	89536	419283	1	1	
Q 19, 20		* DUAL FET,SELECTED OFFSET	476911	78425	476911	2	2	
Q 23, 24		* TRANSISTOR,SI,BV= 80V, 10W,TO-202	495697	04713	MPS-U06	2	1	
Q 26		* TRANSISTOR,SI,BV= 40V, 2W,TO-220	473207	01295	TIP30	1	1	
R 1		RES,WW,11.75K,+-0.05%,0.125W	603258	89536	603258	1		
R 2, 31, 47		RES,CF,10K,+-5%,0.25W	348839	80031	CR251-4-5P10K	3		
R 3		RES,CF,1K,+-5%,0.25W	343426	80031	CR251-4-5P1K	1		
R 6, 45		RES,MF,61.9K,+-1%,0.125W,100PPM	237230	91637	CMF556192F	2		
R 7, 44		RES,VAR,CERM,500,+-10%,0.5W	325613	89536	325613	2		
R 8, 32		RES,CF,3.3K,+-5%,0.25W	348813	80031	CR251-4-5P3K3	2		
R 9		RES,CF,43K,+-5%,0.25W	442418	80031	CR251-4-5P43K	1		
R 10		RES,CF,27K,+-5%,0.25W	441501	80031	CR251-4-5P27K	1		
R 11, 12, 22- 25		RES,MF,10.02K,+-0.1%,0.125W,50PPM	352245	89536	352245	6		
R 13		RES,MF,1K,+-1%,0.125W,100PPM	168229	91637	CMF551001F	1		
R 14		RES,VAR,CERMET,500K,+-10%,0.5W	474387	11236	360T-504A	1		
R 15		RES,MF,49.9,+-1%,0.125W,100PPM	305896	91637	CMF5549R9F	1		
R 16		RES,MF,169K,+-1%,0.125W,100PPM	289454	91637	CMF551693F	1		
R 17		RES,MF,215K,+-1%,0.125W,100PPM	289470	94637	CMF552153F	1	1	

An * in 'S' column indicates a static-sensitive part.

Table 5-2. A1 Main PCB Assembly (cont)

REFERENCE DESIGNATOR	FLUKE STOCK	MFRS SPLY	MANUFACTURERS PART NUMBER	TOT	R S	N T
-A>-NUMERICS--> S-----DESCRIPTION-----	--NO--	-CODE-	-OR GENERIC TYPE-----	QTY-	-Q-	-E-
R 18	RES,CF,12K,+/-5%,0.25W	348847	80031 CR251-4-5P12K	1		
R 19	RES,MF,20K,+/-1%,0.125W,100PPM	291872	91637 CMF552002F	1		
R 20	RES,MF,2K,+/-1%,0.125W,100PPM	235226	91637 CMF552001F	1		
R 21	RES,MF,221,+/-1%,0.125W,100PPM	340794	91637 CMF552210F	1		
R 26	RES,MF,100,+/-0.1%,0.125W,25PPM	357400	91637 CMF551000B	1		
R 27	RES,VAR,CERM,1K,+/-20%,0.5W	267856	11236 190PC102B	1		
R 28, 29	RES,VAR,CERM,10K,+/-20%,0.5W	267880	75378 190PC103B	2		
R 30, 41	RES,CF,47K,+/-5%,0.25W	348896	80031 CR251-4-5P47K	2		
R 33, 53	RES,CF,330,+/-5%,0.25W	368720	80031 CR251-4-5P330E	2		
R 35	RES,CF,100,+/-5%,0.25W	348771	80031 CR251-4-5P100E	1		
R 36	RES,MF,9.09K,+/-1%,0.125W,100PPM	221663	91637 CMF55901F	1		
R 37	RES,MF,1.02K,+/-1%,0.125W,100PPM	223545	91637 CMF551021F	1		
R 38	RES,MF,4.32K,+/-1%,0.125W,100PPM	294819	91637 CMF554321F	1		
R 39	RES,MF,10K,+/-1%,0.125W,100PPM	168260	91637 CMF551002F	1		
R 42	RES,CF,5.1K,+/-5%,0.25W	368712	80031 CR251-4-5P5K1	1		
R 48	RES,CF,39K,+/-5%,0.25W	442400	80031 CR251-4-5P39K	1		
R 49	RES,MF,100K,+/-1%,0.125W,100PPM	248807	91637 CMF551003F	1		
R 50	RES,MF,64.9K,+/-1%,0.125W,100PPM	288530	91637 CMF556493F	1		
R 51	RES,MF,226K,+/-1%,0.125W,100PPM	320879	91637 CMF552263F	1		
R 52	RES,MF,309K,+/-1%,0.125W,100PPM	235283	91637 CMF553093F	1		
R 55	RES,VAR,CERM,25K,+/-10%,0.5W	500769	32997 3299W-W-253	1		
S 1	SWITCH PUSHBUTTON ASSY	483891	89536 483891	1		
S 3, 4	SWITCH,SLIDE,DPDT,POWER	234278	89536 234278	2	1	
T 1	POWER TRANSFORMER	464370	89536 464370	1		
T 2	TRANSF,INV,MULTIPLE OUTPUT,TOROID	461954	89536 461954	1		
TB 1	TERM STRIP,PWB,RT ANG,0.200CTR,2 POS	479006	89536 479006	1		
TP 1- 4, 6,	TERM,UNINSUL,FEEDTHRU,HOLE,TURRET	179283	88245 2010B-5	7		
TP 8, 16		179283				
U 1	* IC,COMPARATOR,8 PIN DIP	352195	01295 SN72311P	1	1	
U 2	* IC,OP AMP,JFET INPUT,TO-5 CASE	429837	12040 LF356F	1	1	
U 3, 7	* IC,OP AMP,JFET INPUT,8 PIN DIP	472779	12040 LF386N	2	1	
U 4, 15	* IC,OP AMP,GENERAL PURPOSE,8 PIN DIP	413740	12040 LM307N	2	1	
U 5	* IC,OP AMP,SOURCE CNTRL,DUAL,LO-NOISE	478032	04713 MC4558NCP1	1	1	
U 6A	* RES NET ASSY TESTED (2180/2190 DIV)	510628	89536 519628	1		
U 6B	* RES DIV RES NET ASSY TESTED 2180/2190	577536	89536 577536	1		
U 8	RES,NET,SIP,8 PIN,7 RES,47K,+/-2%	413286	89536 413286	1		
U 10	* IC,OP AMP,SELECTED GBW 600KHZ	418566	12040 LM358N	1	1	
U 11	* IC,VOLT REG,FIXED,-15 VOLTS,1.5 AMPS	413179	04713 MC7915CP	1	1	
U 12	* IC,VOLT REG,FIXED,+15 VOLTS,1.5 AMPS	413187	04713 MC7815CT	1	1	
U 13	* IC,CMOS,HEX OPEN DRAIN BUFFER	473389	12040 MM74C906N	1	1	
U 14	RES,NET,DIP,16 PIN,8 RES,680,+/-5%	402644	89536 402644	1	1	
U 16	* IC,COMPARATOR,DUAL,LO-PWR,8 PIN DIP	478354	12040 LM393N	1	1	
VR 3, 4	* ZENER,UNCOMP,36.0V,5%,3.4MA,0.4W	186163	04713 1N974B	2	1	
VR 18	* ZENER,COMP,6.4V,2%,2 PPM TC,0.5MA	393579	04713 1N4567	1		
X 1	SOCKET,IC,40 PIN	329282	09922 DILB40P-108	1		
Y 1	* CRYSTAL,4MHZ,+/-0.02%,HC-18/U	474072	89536 474072	1		

An * in 'S' column indicates a static-sensitive part.



Option -004 IEEE-488 Interface

604-1. INTRODUCTION

604-2. Option 21X0A-004 IEEE-488 Interface provides the 2180A and 2190A digital thermometers with a direct output only connection to the IEEE-488 bus.

604-3. Option 21X0A-004 may be ordered with the 2180A and 2190A thermometers for factory installation, or is available by itself for service center installation. Option 21X0A-004 cannot be used in a 2300A Scanner system. For more compatibility information, refer to "Compatibility With 2300A and Previously Produced Thermometers".

604-4. The IEEE-488 standard connector is accessible from the rear panel of the thermometer. The format of the output data includes the channel number, the current reading, and any out-of-range or open thermocouple information. (Refer to Table 604-3.)

604-5. SPECIFICATIONS

604-6. Specifications for Option 21X0A-004 are shown in Table 604-1.

NOTE

The L4 listener function indicates that the thermometer IEEE-488 bus interface has the same 5-digit talk and listen addresses, and that the receipt of a listen address disables the talk address.

604-7. IEEE-488 BUS ADDRESS CODE SELECTION

604-8. A six-position dip switch (SW3), located on Option 21X0A-004 pca (printed circuit assembly), sets the IEEE-488 bus address codes for the option. To gain access to SW3, lift off the case top of the thermometer by remov-

ing the six screws from the base. Referring to Table 604-2, set positions 1 through 5 of SW3 to assign the desired address.

604-9. OPERATION

604-10. Once Option 21X0A-004 is installed and SW3 is properly set, make sure that the IEEE-488 cable is correctly connected to the option to ensure that all functions are properly monitored by the controller.

604-11. Program Considerations

604-12. Position 6 on SW3 controls the SRQ signal (Service Request) to the IEEE-488 bus. Upon receiving an SRQ, the controller serially polls each device on the bus for SRQ status. SRQ status of the Option 21X0A-004 is indicated by bit DB6 (position 64 decimal, 40 hexadecimal) in the serial poll register (UI2). With SW3 position 6 in the ON position, SRQ is generated when a LF (line feed) is received in the 32-byte buffer of Option 21X0A-004. The LF character is used by the thermometer to indicate the end of a data transfer to the Option 21X0A-004. (Refer to Table 604-3.) Option 21X0A-004 sets DB1 (2 decimal), which causes a serial poll to return a total value of decimal 66 or 42 hexadecimal.

604-13. When the SRQ mode is enabled, the SRQ is set when the thermometer makes a reading available to the Option 21X0A-004. The reading is held indefinitely until the SRQ is serviced. All new readings from the thermometer are discarded. When SRQ is disabled, the output buffer is continuously updated with the most recent reading from the thermometer. However, there may be a 0.33 second delay encountered in the returned reading. This delay occurs when one reading is sent across the IEEE bus and the Option 21X0A-004 waits for the thermometer to send the next reading. An IEEE bus timeout error may occur unless the timeout is set longer than this delay.

Table 604-1. Option 21X0A-004 Specifications

ENVIRONMENTAL		
Operating Power	100, 200, 220, 240V ac ± 10% 50/60 Hz, 3VA. (The 12-volt battery operation is not supported.)	
Operating Temperature	40°C (Outside ambient of thermometer.)	
OPERATIONAL CONTROL		
	Switch 3 (SW3)	
OUT-OF-LIMIT-SIGNAL		
	Exclamation point transmitted with Option 21X0A-006 installed only; not with Y2002.	
OUTPUT		
Protocol and Connections	IEEE-488 standard	
IEEE-488 Interface Function Capability Codes		
IDENTIFICATION	FUNCTION	CAPABILITY
SH1	Source Handshake	Full
AH1	Acceptor Handshake	Full
T6	Talker	Serial Poll (not talk only)
L4	Listener	Not listen only (see note)
SR1	Service Request	Full
DT1	Device Trigger	Full (see 604-22. for function description)

604-14. Message Format

604-15. Table 604-3. contains the sequence of information in the output data string. The sequence is the fixed length format presented on the IEEE bus.

604-16. Sample Programs

604-17. The following sample programs show two different situations in which the controller receives temperature readings from the thermometer. The program listed in Figure 604-1 instructs the controller to asynchronously retrieve a temperature reading after an SRQ has been sent from the thermometer. The program listed in Figure 604-2 instructs the controller to ask for a temperature reading at a specific program step.

604-18. SRQ Program

604-19. The SRQ program, when typed into a 1720A, 1722A, or 1752A controller informs the controller what to do when an SRQ is received from the thermometer. The program allows the controller to perform other tasks until the thermometer has a temperature reading. The thermometer sends a 66 hexadecimal value back to the controller in response to the serial poll (SPL). If more than one thermometer or more than one other instrument (a maximum of 14) is connected to the controller, the program distinguishes which instrument is sending the SRQ and deter-

mines priority if more than one SRQ is received at the same time. After the controller receives the temperature reading and prints it on the controller screen, the program ends the SRQ handling procedure and waits for another SRQ.

NOTE

The following programs are written in Fluke BASIC and operate on the 1720A, 1722A, and 1752A controllers. A modification of the SRQ program may be required to conform to other IEEE controllers.

604-20. The Non-SRQ Program

604-21. The sample program in Figure 604-2 inputs and prints temperature readings without the use of an SRQ. A 2-second delay is required after the TRIG @2 statement (line 50) to allow Option 21X0A-004 to finish the reset process before requesting readings from it. The TIMEOUT delay (line 70) must be set greater than 333 ms, so the controller waits for the thermometer to provide the next reading to the INPUT statement.

604-22. Group Execute Trigger

604-23. The Option 21X0A-004 responds to the IEEE-488 GET command by simply resetting the two microprocessors (U5 and U11) on the board. Resetting the micro-

Table 604-2. Switch 2, IEEE-488 Bus Address Selection

ADDRESS CODES	ADDRESS SWITCH SETTINGS				
	16 (5)	8 (4)	4 (3)	2 (2)	1 (1)
0	0	0	0	0	0
1	0	0	0	0	1
2	0	0	0	1	0
3	0	0	0	1	1
4	0	0	1	0	0
5	0	0	1	0	1
6	0	0	1	1	0
7	0	0	1	1	1
8	0	1	0	0	0
9	0	1	0	0	1
10	0	1	0	1	0
11	0	1	0	1	1
12	0	1	1	0	0
13	0	1	1	0	1
14	0	1	1	1	0
15	0	1	1	1	1
16	1	0	0	0	0
17	1	0	0	0	1
18	1	0	0	1	0
19	1	0	0	1	1
20	1	0	1	0	0
21	1	0	1	0	1
22	1	0	1	1	0
23	1	0	1	1	1
24	1	1	0	0	0
25	1	1	0	0	1
26	1	1	0	1	0
27	1	1	0	1	1
28	1	1	1	0	0
29	1	1	1	0	1
30	1	1	1	1	0

```

10 ON ERROR GOTO 250
20 ON CTRL/C GOTO 260
30 INIT PORT 0
40 CLEAR PORT 0
50 TRIG @2
60
70
80
90 ON SRQ GOTO 140
100
110
120 GOTO 120
130
140 IF SPL(2) < > 66 RESUME
150
160
170
180
190 INPUT @2, A$
200
210 PRINT A$
220 RESUME
230
240
250 PRINT 'OOPS!!! ERROR #'; ERR; ' ON LINE #'; ERL
260 PRINT 'bye-bye'
270 END

```

Initialization

"

Send "Group Execute Trigger" to reset the -004, which is arbitrarily set at address 2 on Port 0.

Now, tell the program what to do if an SRQ comes.

Most of the time it just sits here.

"spl(2)" clears the SRQ. The -004 sends a 66(42 Hex) if it set the SRQ, otherwise it sends a 0. This discriminates between other instruments on the Port that could send an SRQ. This command gets the thermometer reading from the -004.

This command prints the reading. Ends the SRQ handling and goes to wait for another.

Figure 604-1. SRQ Sample Program

Table 604-3. Message Format

CHARACTER POSITION																				
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
NORMAL TEMPERATURE MEASUREMENT DATA																				
CH	CH	SP	SP	±	SP	D	D	D	D/.	D/.	D	SP	d	F/C	SP	!	SP	SP	CR	LF
OPEN THERMOCOUPLE OUTPUT (2190A only)																				
CH	CH	SP	SP	±	SP	D	D	D	D/.	D/.	D	SP	d	F/C	SP	!	O	C	CR	LF
OVERLOAD OUTPUT																				
CH	CH	SP	SP	±	SP	D	D	D	D/.	D/.	D	SP	d	F/C	SP	!	O	L	CR	LF

SYMBOL	DESCRIPTION
CH	Channel identification numbers (00 through 99, 00 unless connected to Y2000, Y2001, or 2300A).
SP	Space
±	Plus or minus symbol
D	Temperature data values (0 through 9) for the 2180A, position 12 for the 2190A.
D/.	Either a temperature data value or a decimal point
d	a lower case (d)
F/C	Fahrenheit or Celsius
!	Character (!) when the present limit of the Limits Option 21X0A-006 is exceeded.
OC	One space if within limits.
OL	Open (thermo)couple (character positions 18 and 19)
CR	Overload (character positions 18 and 19)
LF	Carriage Return
	Line Feed

```
10 ON ERROR GOTO 250
20 ON CTRL/C GOTO 260
30 INIT PORT 0
40 CLEAR PORT 0
50 TRIG @2
60 WAIT 2000                                !Wait for -004 to finish reset process
70 TIMEOUT 350                             !Set IEEE timeout longer than reading delay
190 INPUT @2,A$                             !Request a reading
210 PRINT A$
220 GOTO 190
250 PRINT 'DUPS!!! ERROR #';ERR; ' ON LINE #';ERL
260 PRINT 'bye-bye'
270 END
```

Figure 604-2. Non-SRQ Sample Program

rocessors ensures that they are synchronized properly with the IEEE-488 interface chip (U12), and is a recommended start-up procedure at the beginning of the program in the IEEE-488 controller. A 2 second time delay is required to complete the resetting operation. Do not attempt to access Option 21X0A-004 before the end of the time delay.

604-24. Functional Equivalent

604-25. The operation of Option 21X0A-004 is functionally equivalent to the combination of the Fluke 21X0A-002, 2XXXA-522, and 1120A with the exception of the following four items:

CHANGES:

1. Option 21X0A-004 displays a lower case (d) instead of a blank in front of the temperature scale indicator. See Output Format, Table 604-3.
2. Option 21X0A-004 operates at the full speed rate of the thermometer, (3 readings per second, instead of 1.5 readings per second).
3. The 2XXXA-522 previously contained a buffer-full SRQ function that produced an SRQ when the 32-byte buffer is filled. The buffer-full SRQ function no longer exists with the 2XXXA-522, but the switch is still present and its function is still listed in the 2XXXA-522 manual. The buffer-full SRQ function is not available on Option 21X0A-004.

ADDED FEATURE:

4. Option 21X0A-004 responds to a Group Execute Trigger. See Group Execute Trigger, paragraph 604-23.

604-26. If you include Option 21X0A-004 when upgrading or adding new equipment to a system currently operating with the 21X0A-002, 2XXXA-522, or 1120A combination, note the first two changes listed in paragraph 604-25.

604-27. THEORY OF OPERATION

604-28. Option 21X0A-004 converts the temperature displayed by the thermometer into a format usable by an IEEE-488 Bus Controller. Option 21X0A-004 communicates with the thermometer on the clocked bit-serial accessory bus. The channel number, range, conversion type, scale, and digits of the temperature reading are transmitted on the bus. The cycle is repeated every 333 ms. When the Write Address (WRTADR-) line is held low, Data Clock

(DCLK-) clocks the accessory bus address then the thermometer data into the 3870 microprocessor (U5) on the DATA- line. In U5, the data is formatted (Table 604-2) and made available for transfer to the 8748 microprocessor (U11).

604-29. U5 applies a character to the tri-state buffers (U8 and U9) and pulls the Data Valid (DATVAL) line low. If U11 is not transferring data to U12 or if it is waiting for SRQ to be serviced, U11 responds to U5 by strobing the character onto the Option Data Bus with a STROBE- signal and reads the character into its 32-byte buffer. U11 also generates Acknowledge (ACK), which causes U5 to reply with a new character. When an LF character is detected, U11 unmask the byte-out interrupt. If the SRQ switch is set to ON, the SRQ switch triggers the GPIA (General Purpose Interface Adapter) to send SRQ to the controller. The 32-byte buffer never completely fills because thermometer readings consist of 21 bytes.

604-30. The IEEE-488 Bus Controller initiates the talk mode by sending the talk address to the GPIA (U12) over the IEEE-488 bus when Attention (ATN) is asserted true low. The GPIA responds by setting the byte-out interrupt (U12-40) high, as a signal to U11 to pass data bytes to U12. The following three conditions must be met before data transfer can begin:

- Ready For Data (RFD) from the IEEE-488 bus is true (low).
- Data Accepted (DAC) from the IEEE-488 bus is false (high).
- U11 must have the byte-out interrupt unmasked.

604-31. When the above conditions are met, U11 sends the data byte to the Data Out Register of the GPIA via the Option Data Bus. At this time, the byte-out interrupt is set to zero, and the data byte is checked for the LF character. The GPIA handshakes the data byte to the IEEE-488 Bus, and the byte-out interrupt (U12-40), transmitted to U11, is set to 1. If the data byte is an LF character, EOI (End or Identify) is also sent to the IEEE Controller to signal the end of a data reading. This process continues as long as there is data in the 32-byte buffer of U11. When the 32-byte buffer is empty, U11 masks the byte-out interrupt from the GPIA.

604-32. The IEEE-488 address setting for Option 21X0A-004 is read by the GPIA (U12) via the Option 21X0A-004 data bus when the GPIA sends a strobe out on U12-4 to the address switch tri-state buffers (U18).

604-33. When the GPIA detects a Group Execute Trigger for its address, it sets U12-24 to a logic high to cause a

Power On Reset (POR) via Q4 and U16. The POR resets U5 and U11, and lasts for approximately 150 ms.

604-34. The power supply for Option 21X0A-004 power supply is a standard linear regulator using a full-wave center tap rectifier and pass transistor regulator (Q5). The regulator is driven by U17 and Q6, and is referenced from a 2.5-volt band gap reference (U15). U16 performs POR and low voltage detection. The option provides its own power rather than using the power supply of the thermometer, which is unable to provide enough additional power.

604-35. Option 21X0A-004 is a consolidation of the circuitry from Option 21X0A-002, Option 2XXXA-522, and 1120A that is required for IEEE-488 output operation. The consolidated circuitry does not include analog output capability or the slow serial communication link between the Option 21X0A-002 and 2XXXA-522 microprocessors. Instead, the circuitry uses the PTI (Portable Test Instrument) parallel output port of the Option 21X0A-002 to communicate with the Option 2XXXA-522 microprocessor.

604-36. COMPATIBILITY WITH 2300A AND PREVIOUSLY PRODUCED THERMOMETERS

604-37. Option 21X0A-004 is not intended to be used with a thermometer that is a part of a 2300A Scanning System. In a 2300A system, an Option 2300A-005 or Option 2300A-006 should be installed in the 2300A for connection to the IEEE-488 bus. Option 2300A-005 is for output only, similar to Option 21X0A-004 operation. Option 2300A-006 additionally provides remote control of the 2300A. Options 2300A-005 and 2300A-006 use the 2XXXA-522 and 1120A for connection to the IEEE bus.

CAUTION

Option 21X0A-004 is not compatible with a 2300A Scanning System. Such use may cause channel numbers to be displaced by one reading, and each reading may be output twice.

604-38. Option 21X0A-004 is not directly compatible with the earliest version of the 2180A and 2190A thermometers. A choice of either of the two modifications described below provides compatibility. To identify the early version of thermometer, observe the thermometer display as it is turned on. If the display characters begin with "2180" or

"2190", the thermometer is an early version. Newer versions begin with "800" or "900."

604-39. If your thermometer is an early version, either of the following two modifications may be performed:

1. The microprocessor in the thermometer can be replaced with a newer version. Contact your local John Fluke Service Center to order the latest 2180A or 2190A standard versions.
 - a. When you are updating a 2180A to the latest version, be aware there are changes in the available choice of Resistance Temperature Detector (RTD) linearizations. If you require the original linearizations, order a special retrofit kit Model 2180A/AYK. (P/N 796953)
 - b. When you are selecting from the latest versions of 2190A linearizations, be aware that an enhanced microprocessor retrofit kit is also available. The enhanced retrofit kit provides 15 thermocouple types. Order Model 2190A/AMK (P/N 763292)
2. A modification to Option 21X0A-004 may alternatively be performed. Contact your local John Fluke Service Center and arrange for the installation of a 2180A-4021W (JF P/N 539288) onto Option 21X0A-004. Q1 and Q3 are removed from the pca and replaced by the modification circuit. This modification makes Option 21X0A-004 compatible with all versions of 2180A and 2190A thermometers. A +5 volt connection is provided next to U2 to provide power to the added modification circuit.

604-40. PERFORMANCE TEST

604-41. There are no adjustments or calibration.

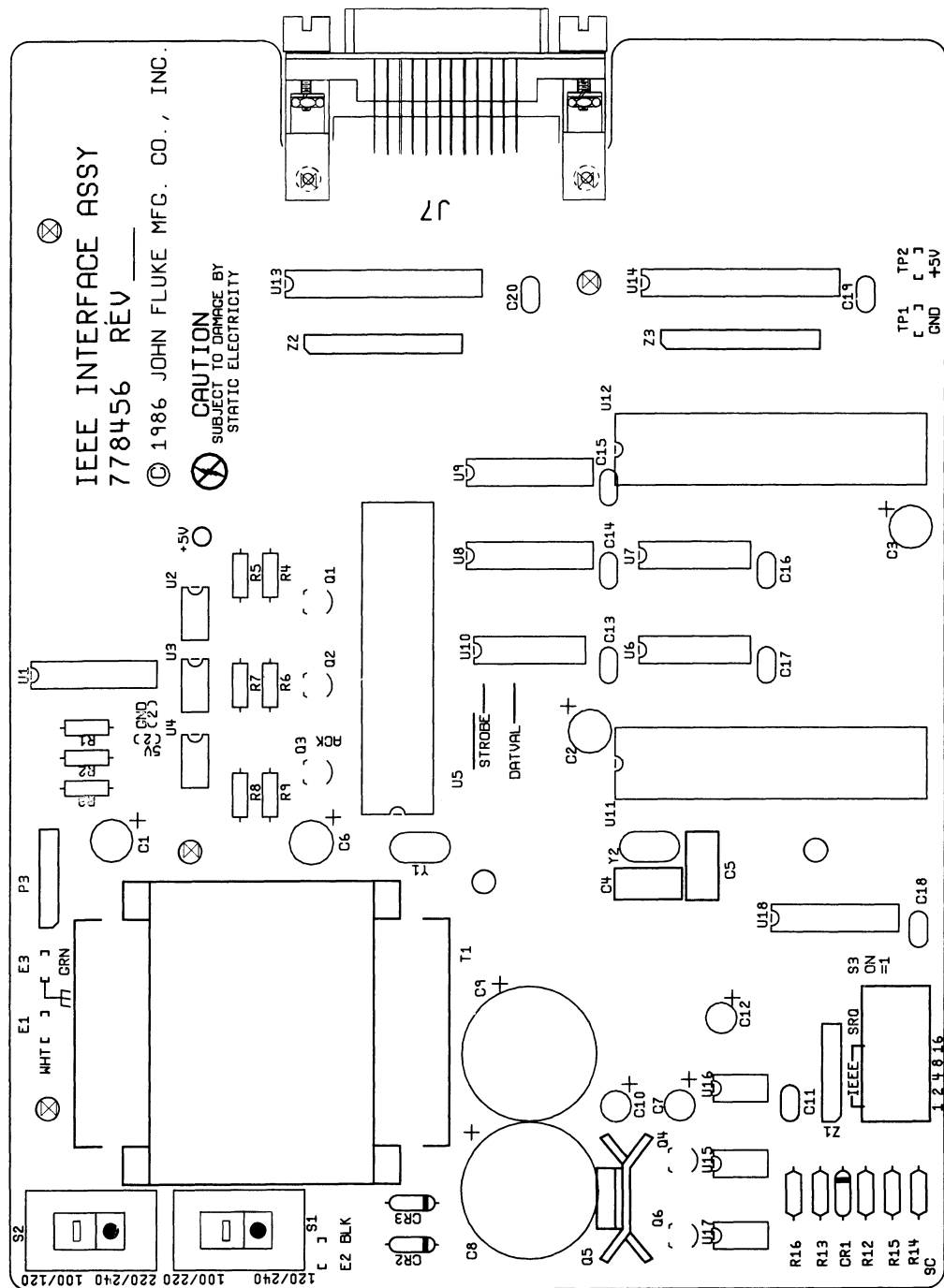
604-42. With Option 21X0A-004 attached to a 2180A or 2190A thermometer, apply proper ac input voltage and measure for 5.05 ± 0.1 volts dc across TP1 and TP2.

604-43. Connect Option 21X0A-004 to an IEEE-488 controller via the IEEE-488 bus. Execute the SRQ program in Figure 604-1 to retrieve readings from Option 21X0A-004.

Table 604-5. Option -004 IEEE-488 Interface PCB Assembly
(See Figure 604-3.)

REFERENCE DESIGNATOR			FLUKE STOCK	MFRS SPLY	MANUFACTURERS PART NUMBER	TOT	R S	N T
-A>-NUMERICS-----	S-----	DESCRIPTION-----	--NO--	-CODE-	-OR GENERIC TYPE-----	QTY-	-Q	-E-
C	1, 2, 3,	CAP,TA,10UF,+20%,20V	330662	56289	196D106X0020KA1	4		
C	6		330662					
C	4, 5	CAP,MICA,22PF,+5%,500V	148551	02799	DM15C220J	2		
C	8, 9	CAP,AL,3300UF,+30-10%,16V,SOLV PROOF	603472	89536	603472	2		
C	10, 12, 16	CAP,TA,1UF,+10%,35V	161919	56289	196D010X0035G	3		
C	11, 13- 20	CAP,CER,0.22UF,+20%,50V,Z5U	519157	51406	RPE111Z5U224M50V	9		
CR	1	* DIODE,SI,BV=75V,IO=150MA,500MW	203323	07910	1N4448	1		
CR	2, 3	* DIODE,SI,100 PIV,1.5 AMP	116111	05277	1N4817	2	1	
E	1, 2, 3	TERM,FASTON,TAB,SOLDR,0.110 WIDE	512889	02660	62395	5	1	
H	1	SCREW,MACH,SEMS,PH,P,STL,6-32X0.375	177022	89536	177022	2		
H	2	NUT,HEX,S.STL,4-40	147611	89536	147611	2		
H	3	SCREW,MACH,PH,P,4-40X0.375	837690	89536	837690	2		
H	4	SCREW,CONNECTOR MOUNTING	429472	89536	429472	2		
H	5	NUT,MINI,HEX,SS,6-32	110569	89536	110569	2		
H	6	HARDWARE KIT (FOR J7)	435750	89536	435750	1		
H	7	WASHER,LOCK,SPLIT,STEEL,#4	110395	89536	110395	2		
J	7	CONN,MICRO-RIBBON,REC,PWB EDGE,24POS	484220	89536	484220	1		
MP	1	SPACER,POLY-E,SW-STANDOFF HT,0.063	285346	89536	285346	2		
MP	2	SHIELD, IEEE I/F ASSY.	795427	89536	795427	1		
P	3	CABLE,FLAT,JMPR,6 CONDUCT,0.100 SP	474155	00779	86942-5	1		
Q	1- 4, 6	* TRANSISTOR,SI,NPN,SMALL SIGNAL	218396	04713	2N3904	5	1	
Q	1	RIVET,PUSH,BI,NYL,0.118X0.217	745869	89536	745869	1		
Q	2	HEAT DIS,VERT MT,1.25X0.875,TO-220	524934	13103	6025B-TT	1		
Q	5	* TRANSISTOR,SI,BV= 40V, 2W,TO-220	473207	01295	TIP30	1	1	
R	1, 2, 3	RES,CF,10K,+5%,0.25W	348839	80031	CR251-4-5P10K	3		
R	4, 6, 8	RES,CF,220K,+5%,0.25W	348953	80031	CR251-4-5P220K	3		
R	5, 7, 9	RES,CF,2.2K,+5%,0.25W	343400	80031	CR251-4-5P2K2	3		
R	12	RES,MF,226K,+1%,0.125W,100PPM	320879	91637	CMF552263F	1		
R	13	RES,MF,309K,+1%,0.125W,100PPM	235283	91637	CMF553093F	1		
R	14	RES,MF,10.2K,+1%,0.125W,100PPM	293605	91637	CMF551022F	1		
R	15	RES,MF,10K,+1%,0.125W,100PPM	168260	91637	CMF551002F	1		
R	16	RES,CF,100,+5%,0.25W	348771	80031	CR251-4-5P100E	1		
S	1, 2	SWITCH,SLIDE,DPDT,POWER	234278	89536	234278	2		
S	3	SWITCH,DIP,DPST,PIANO,6 POS	800037	89536	800037	1		
T	1	5 VOLT TRANSFORMER	747881	89536	747881	1		
U	1	* IC,CMOS,HEX BUFFER	381830	02735	CD4050AE	1	1	
U	2, 3, 4	* ISOLATOR,OPTO,LED TO TRANSISTOR	380014	01295	T1L116	3	1	
U	5	* IC,NMOS,8 BIT MICROCOMPUTR,2190A-9403	495309	89536	495309	1		
U	6	* IC,LSTTL,QUAD 2 INPUT NAND GATE	393033	01295	SN74LS00N	1	1	
U	7	* IC,LSTTL,HEX INVERTER	393058	01295	SN74LS04N	1	1	
U	8, 9, 18	* IC,CMOS,HEX BUFFER W/3-STATE OUTPUT	407759	12040	MM80C97N	3	1	
U	10	* IC,LSTTL,DUAL D F/F,+EDG TRG,W/CLR	393124	01295	SN74LS74N	1	1	
U	11	* IC,NMOS,8 BIT MICROCOMPTR,1KX8 EPROM	454652	34649	C8748	1		
U	12	* IC,NMOS,GEN PURPOSE INTERFACE ADAPTOR	477794	04713	MC68488P	1	1	
U	13, 14	* IC,LSTTL,OCTL IEEE-488 BUS TRANSCVR	524835	04713	MC3447P	2	1	
U	15	* IC, 2.5 V,40 PPM T.C.,BANDGAP REF	472845	04713	MC1403V	1	1	
U	16	* IC,COMPARATOR,DUAL,LO-PWR,8 PIN DIP	478354	12040	LM393N	1	1	
U	17	* IC,OP AMP,SELECTED DIFF OUT VOLT=2MV	473777	89536	473777	1	1	
XU	5, 11, 12	SOCKET,IC,40 PIN	429282	09922	DILB40P-108	3	1	
Y	1	* CRYSTAL,4MHZ,+0.02%,HC-18/U	474072	89536	474072	1	1	
Y	2	* CRYSTAL,6MHZ,+0.01%,HC-18/U	461665	89536	461665	1	1	
Z	1	RES,NET,SIP,6 PIN,5 RES,100K,+2%	412726	89536	412726	1		
Z	2, 3	RES,NET,SIP,10 PIN,9 RES,100K,+2%	461038	80031	95081002CL	2		

An * in 'S' column indicates a static-sensitive part.



CAUTION
SUBJECT TO DAMAGE BY
STATIC ELECTRICITY

WARNING: ⚡ INDICATES USAGE OF MOS DEVICE(S)
WHICH MAY BE DAMAGED BY STATIC DISCHARGE. USE SPECIAL
HANDLING PER S.O.P. 19.1

21X0A-1601

Figure 604-3. Option -004 IEEE-488 Interface PCB Assembly

Option -006 Limits

606-1. INTRODUCTION

606-2. The 21X0-006 Limits Option gives the 2180A and 2190A Digital Thermometers the capability of providing both visual and electrical indications (alarms) when the temperature measurement exceeds either of a pair of selectable maximum/minimum limit values. Also selectable are, all for a single point, the delta function (displays the difference between the preset value and the temperature read), and the maximum/minimum display function (the highest or lowest temperature read since the last reset by the INITIALIZE MAX/MIN switch).

606-3. The Limits Option is available as factory installed with initial order or may be ordered as a field installable kit for addition to the instrument.

606-4. SPECIFICATIONS

606-5. Specifications for the Limits Option, 21X0-006, are as listed in Table 606-1.

Table 606-1. Specifications

Limits Function: lights LED and activates Form A (SPST) relay when a preset limit is exceeded. Contacts rated at 10 VA, 184V dc or 130V ac rms max, 0.5A max, resistive.	
Min/Max Function: Store min or max readings, resettable from front panel.	
Δ Temperature Function: Reads ± temperature deviations from preset nominal temperature.	
Installable: Factory or field, through pre-punched front panel.	
Function:	Limit:
≤ Low Limit	−9999°
> High Limit	+9999°
Store min reading	Not used
Store max reading	Not used
Δ ± Deviation from	Nominal

606-6. INSTALLATION

606-7. Options for field installation can be installed using the following procedure:

WARNING

HAZARDOUS VOLTAGES MAY BE PRESENT WITHIN THE INSTRUMENT. ONLY QUALIFIED PERSONNEL SHOULD PERFORM THIS INSTALLATION PROCEDURE.

1. Disconnect the thermometer from all power sources.
2. Remove the screws on the bottom of the case that fasten the top and bottom of the PTI case together and remove the top half of the case.
3. Remove the hole plugs from the Limits section of the front panel and attach the standoffs supplied with the option to the front panel.
4. Position the Limits PCB so that the thumbwheel LED and pushbutton switch line up with the applicable front panel ports.
5. Attach the Limits PCB to the Main PCB using the screws supplied with the option.
6. Connect the cable on the Limits PCB to J4 on the Main PCB.
7. Replace the PTI cover on the instrument and reconnect to input power sources, if required, at this time.

606-8. OPERATING NOTES

606-9. Installation of the Limits Option enables the low current single contact relay (K1) on the thermometer Main PCB. The contact points are available on a rear panel connector block.

NOTE

Once installed, there are no provisions for disabling the Limits Option. If a temperature display is desired without the relay or LED indications, select one of the Limits functions ($>$ or \leq) and the maximum setting on the numeric thumbwheel switches.

606-10. OPERATION

606-11. The position and general description of the Limits Option front panel controls is given in Section 2. A more detailed description of the three functions is given in the following paragraphs. The term "thermocouple" = "RTD" for the 2180A.

606-12. Limits Function

606-13. The Limits function is enabled when the function portion of the thumbwheel is set in either the \leq or $>$ position. The front panel LED illuminates and the rear panel relay contacts close when either of the preset conditions are met. In the greater than ($>$) function the indications (LED and relay contacts) result from any temperature reading that exceeds the value set on the limits thumbwheels. The less than (\leq) function gives its indication when the temperature read by the thermometer is equal to, or less than, the value set on the limits thumbwheels. The thumbwheel LSD is a whole number, fractional entries cannot be made.

606-14. Delta Function

606-15. When the Delta (Δ) function is selected on the thumbwheel the thermometer display reads the difference between the temperature at the thermocouple and the whole number setting of the thumbwheels. The formula used for the computation is:

$T \text{ displayed} = T \text{ at thermocouple} - T \text{ thumbwheel setting}$
(in degrees)

606-16. MINIMUM/MAXIMUM Display Function

606-17. The microcomputer accumulates and stores the highest and lowest temperatures recorded since the last reset. When the Maximum (\uparrow) function is selected the highest temperature recorded and stored in the microcomputer is displayed. Selection of the Minimum function (\downarrow) displays the lowest recorded temperature since the last reset. To record the current temperature for either function, select the applicable function and depress the front panel reset switch.

606-18. THEORY OF OPERATION

606-19. The -006 Option supplies the thermometer with the function and numeric data selected on the front panel mechanical thumbwheel switches. When a Limits function is selected, the data is stored for comparison on the option pcb. All communication between the option and the thermometer is done on the clocked serial accessory bus. This bus transmits and receives addresses, thumbwheel data, reset data, and limit status. Refer to the schematic in Section 8 during the Theory of Operation discussion.

606-20. Addressing

606-21. Each of the options on the bus is addressed with a different code. The thermometer uses the address "6" to talk to the Limits Option. To talk to any option the $\overline{\text{WRTADR}}$ (P4-3) line must be brought low, with $\overline{\text{WRT}}$ (P4-4) high, followed by the applicable four address bits applied to the $\overline{\text{DATA}}$ (P4-5) line in succession, toggling $\overline{\text{DCLK}}$ (P4-6) for each bit. This clocks the address into the shift register (U2-15) where it is compared to the Limits Option address and, if valid, (U1-1 low) enables the gates required to shift data to the thermometer (U5-11) and into the Limits Option (U5-2). Details of the data transfer are in subsequent paragraphs.

606-22. Limits Option Outputs

606-23. Before the thermometer can input data from the Limits Option, the Limits circuitry must be addressed as described previously (U1-1 low). Once addressed the $\overline{\text{WRTADR}}$ and $\overline{\text{WRT}}$ lines go high. The low to high transition of $\overline{\text{WRTADR}}$ (U3-6) loads the shift registers from the thumbwheels and RESET switches. The two lines enable the output data line (U1-13) and as the thermometer accepts the data it clocks the serial output shift registers with $\overline{\text{DCLK}}$, transferring the data from the shift register to the thermometer.

606-24. In the thermometer the data is processed by the microcomputer to perform the proper action. For the Limits function the output is compared to the state of the limits and, if exceeded, the indicator illuminated and the relay energized. For the Delta function the temperature is compared against the transmitted value and the difference displayed. If either the Maximum or Minimum function is selected the stored value is displayed, but, in addition, the status of the RESET switch is checked.

606-25. Limits Option Inputs

606-26. The thermometer transmits to the Limits Option only the Limits Exceeded status. After the option has been addressed (U1-1) $\overline{\text{WRTADR}}$ goes high to

disable the addressing circuit (U4-13) while \overline{WRT} stays low to enable the Limits Exceeded input (U5-8) so that \overline{DCLK} can clock the data into the latch (U5-1). A Limits Exceeded indication clocks a high into the latch resulting in a low at the output (U6-12) to turn on CR1. The limit not exceeded or another function selected, loads a low into the latch to turn off the indicator.

606-27. CALIBRATION

606-28. The Limits Option has no variable components and does not require calibration.

606-29. TROUBLESHOOTING

606-30. Troubleshooting for the 2180A Option -006, Limits, consists of the tabular flow chart in Table 606-1. When a step on the flow chart is completed, check for a decision transfer. If no decision is required, perform the next step of the table in sequence.

606-31. LIST OF REPLACEABLE PARTS

606-32. Table 606-2 is a list of replaceable parts for the Limits Option. Refer to Section 5 for an explanation of the columnar entries.

Table 606-2. Limits Option Troubleshooting

STEP NO.	ACTION	Go to the step number given for correct response	
		YES	NO
	NOTE <i>These tests are based on the assumption that the 2180A/2190A has been thoroughly checked out and is free of troubles prior to beginning the test of the Limits Option -006.</i>		
1	Select the less than or equal function (\leq) and set the thumbwheels for a numeric such that the thermocouple input exceeds the preset numeric (e.g., thumbwheels set at +1111 and the ambient temperature used as the thermocouple input).		
2	Does the LIMIT indicator illuminate and the rear panel relay contacts close?	26	3
3	Is the +4 Vdc input from the Main PCB present?	5	4
4	Check the +5 Vdc input, repair as required then resume at Step 1.		
5	Does the signal at U1-1 toggle (vary between logic high and logic low) when viewed with a scope?	13	6
6	Do the \overline{WRT} , \overline{WRTADR} and \overline{DCLK} lines toggle?	8	7
7	Check the inputs on the cable from the microprocessor on the Main PCB. Repair as required then resume at Step 1.		
8	Does the \overline{DATA} line toggle?	10	9
9	Check the cabling and Q1, Q2, U3-8 and their associated components. Repair as required then resume at Step 1.		
10	Are the clock and data signals present at pins 1 and 15 of U2, respectively?	12	11
11	Check U1, U2-2, 11, 12, 13 and U3. Repair as required then resume at Step 1.		
12	Check U4 for the clock and U6 for loading of the data line. Repair as required then resume at Step 1.		
13	Is the function code (\leq) a BCD 0 with pins 4, 5, and 6 of U7 low, the sign (+) at U7-7 high, the numeric MSD BCD code as set at pins 1, 15, 14 and 13 of U9, the second MSD BCD code as set at pins 4, 5, 6, and 7 of U11?	15	14
14	Check the switches and their associated components. Repair as required then resume at Step 1.		
15	Is the clock present at U7-10, U9-10, and U11-10?	17	16
16	Check U4-10, U1-13 and their inputs. Repair as required then resume at Step 1.		

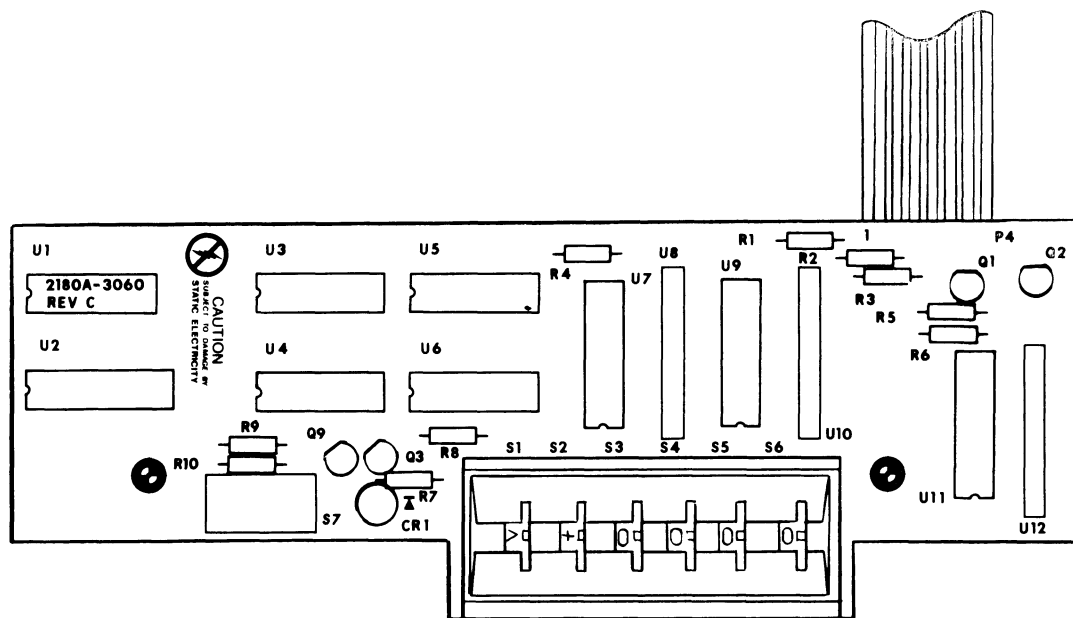
Table 606-2. Limits Option Troubleshooting (cont)

STEP NO.	ACTION	Go to the step number given for correct response	
		YES	NO
17	Does the signal at U11-3, U9-3, and U7-3 toggle?	19	18
18	Check U11, U9, and U7. Repair as required then resume at Step 1.		
19	Does the $\overline{\text{DATA}}$ line toggle?	21	20
20	Check Q1, Q2, U3, U5-10 and their associated components. Repair as required then resume at Step 1.		
21	Are the clock and data signals present at pins 11 and 9 of U6, respectively?	23	22
22	Check U5 for the clock, repair as required then resume at Step 1.		
23	Is the collector of Q9 low?	25	24
24	Check Q9, Q3, U6-12 and their associated components. Repair as required then resume at Step 1.		
25	Check the indicator CR1 and the relay on the Main PCB. Repair as required then resume at Step 1.		
26	Set the FUNCTION switch to greater than (\triangleright) and input a temperature from the thermocouple that exceeds the preset limit.		
27	Does the LIMIT indicator illuminate and the relay contacts close?	29	28
28	Check for a Function BCD code of 1 (001) at pins 4, 5, and 6 of U7. The sign at U7-7 is high for plus and low for minus. Check that the thumbwheel switches reflect the BCD codes set on them. Repair as required then resume at Step 1.		
29	Set the FUNCTION switch to the Delta (Δ) position and set the thumbwheels to the desired base.		
30	Is the difference between the thermocouple input and the preset base displayed?	32	31
31	Check for a Function BCD code of 2 (010) at pins 4, 5, and 6 of U7. Check that the thumbwheel switches reflect the BCD codes set on them. Repair as required then resume at Step 29.		
32	Set the FUNCTION switch to the minimum (\downarrow) position and depress the INITIALIZE MIN/MAX switch.	i n	
33	Does the thermometer display reflect the lowest temperature input from the thermocouple since the switch was depressed?	35	34
34	Check for a Function BCD code of 3 (011) at pins 4, 5, and 6 of U7. Check U2-4 and 5, U4-3 and 4, U6-1, the initialize switch S7 and their associated components. Repair as required then resume at Step 32.		
35	Set the FUNCTION switch to the MAXIMUM (\uparrow) position and depress the INITIALIZE MIN/MAX switch.		
36	Does the thermometer display reflect the highest temperature input from the thermocouple since the switch was depressed?	38	37
37	Check for a Function BCD code of 4 (100) at pins 4, 5, and 6 of U7. Repair as required then resume at Step 35.		
38	Troubleshooting of the 21X0-006 Limits Option is complete.		

Table 606-3. Option -006 Limits PCB Assembly
(See Figure 606-1.)

REFERENCE			FLUKE	MFRS	MANUFACTURERS			N
DESIGNATOR			STOCK	SPLY	PART NUMBER	TOT	R	0
-A>-NUMERICS----->	S-----	DESCRIPTION-----	--NO--	-CODE-	-OR GENERIC TYPE-----	QTY-	-Q-	-E-
CR	1	* LED,RED,PCB MOUNT,LUM INT= >0.6 MCD	385914	09214	SSL-22	1		
H	1	SCREW,MACH,PH,PSTL,6-32X0.500	152173	89536	152173	2		
H	2	SCREW,MACH,SEMS,PH,P,STL,6-32X.500	177030	89536	177030	2		
MP	1	ACTUATOR, SWITCH	412106	89536	412106	1		
MP	2	COVER, PUSHBUTTON SWITCH	401299	89536	401299	1		
MP	3	BUTTON	472332	89536	472332	1		
MP	4	ASSY, LED STANDOFF	472548	89536	472548	1		
MP	5	SPACER,RND,S STEEL,0.143IDX0.250	484865	89536	484865	2		
P	4	CABLE,FLAT,JMPR,7 CONDUCT,0.100 SP	474379	00779	86946-6	1		
Q	1	* TRANSISTOR,SI,PNP,SMALL SIGNAL	195974	64713	2N3906	1	1	
Q	2, 3, 9	* TRANSISTOR,SI,NPN,SMALL SIGNAL	218396	64713	2N3904	3		
R	1- 4, 6,	RES,CF,10K,+/-5%,0.25W	348839	80031	CR251-4-5P10K	6		
R	8		348839					
R	5	RES,CF,100K,+/-5%,0.25W	348920	80031	CR251-4-5P100K	1		
R	7	RES,CF,240,+/-5%,0.25W	376624	80031	CR251-4-5P240E	1		
R	9	RES,CF,20K,+/-5%,0.25W	441477	80031	CR251-4-5P20K	1		
R	10	RES,CF,2.2K,+/-5%,0.25W	343400	80031	CR251-4-5P2K2	1		
S	1	SWITCH,ROTARY,MULT POS,SPECIAL,6THUMB	472803	89536	472803	1		
S	2	SWITCH PART,SPST,SPRING	414516	00779	63212	1		
S	3	SWITCH PART,SPST,FIXED CONTACT	416875	00779	62313	1	1	
U	1	* IC,CMOS,DUAL 4 INPUT NAND GATE	355206	04713	NM14012CP	1	1	
U	2	* IC,CMOS,DUAL,4BIT SER-IN,PAR-OUT SHFT	340125	04713	MC14015CP	1	1	
U	3	* IC,CMOS,HEX INVERTER	404681	02735	CD4069BE	1	1	
U	4	* IC,CMOS,QUAD 2 INPUT NOR GATE	355172	02735	CD4001AE	1	1	
U	5	* IC,CMOS,TRIPLE 3 INPUT NOR GATE	355180	02735	CD4025AE	1	1	
U	6	* IC,CMOS,DUAL D F/F,+EDG TRIG	340117	02735	CD4013AE	1	1	
U	7, 9, 11	* IC,CMOS,DUAL D F/F,+EDG TRIG	380766	02735	CD4021AE	3	1	
U	8, 10, 12	RES,NET,SIP,8 PIN,7 RES,100K,+/-2%	412908	89536	412908	3	1	

An * in 'S' column indicates a static-sensitive part.



2180A-1000

Figure 606-1. Option -006 Limits PCB Assembly

Section 7

General Information

7-1. This section of the manual contains generalized user information as well as supplemental information to the List of Replaceable Parts contained in Section 5.

Federal Supply Codes for Manufacturers

D9816 Westermann Wilhelm Augusta-Anlage Mannheim-Nackarau Germany	01101 Wabash Inc (Formerly Wabash Magnetics) Wabash, IN	02697 Parker-Hannifin Corp. O-Ring Div Lexington, KY	04423 Telonic Berkley Inc. Laguna Beach, CA
S0482 Sony Corp. Tokyo, Japan	01121 Allen Bradley Co. Milwaukee, WI	02735 RCA-Solid State Div. Somerville, NJ	04713 Motorola Inc. Semiconductor Group Phoenix, AZ
S3774 Oshino Electric Lamp Works Tokoyo, Japan	01281 TRW Electronics & Defense Sector R F Devices Lawndale, CA	02768 ITW (IL Tool Works) Fastex Division Des Plaines, IL	04946 Standard Wire and Cable Rancho Dominguez, CA
0AD86 IN General El Paso, TX	01295 TX Instruments Inc. Semiconductor Group Dallas, TX	02799 Arco Electronics Inc. Chatsworth, CA	05173 General Radio NY, NY. Replaced by:
0AE89 Autosplice Inc. Woodside, NY	01526 Genicom Waynesboro, VA	03296 Nylon Molding Corp. Monrovia, CA	24655 Genrad, INC. Concord, MA
0BW21 Noritake Co. Inc. Burlington, MA	01537 Motorola Communications & Electronics Inc. Franklin Park, IL	03445 Lercon Electronics Inc Burbank, CA	05236 Jonathan Mfg. Co. Fullerton, CA
0ANF0 Topaz Semiconductor Inc San Jose, CA	01686 RCL Electronics/Shallcross Inc. Electro Components Div. Manchester, NH	03508 General Electric Co. Semiconductor Products & Batteries Auburn, NY	05245 Corcom Inc. Libertyville, IL
0DSM7 Conductive (Pkg) Containers Inc. Brookfield, WI	01884 Sprague Electric Co. (Now 56289)	03797 Genisco Technology Corp. Eltronics Div. Rancho Dominguez, CA	05276 ITT Pomona Electronics Div. Pomona, CA
0CLN7 Emhart Fastening Group Shelton, CT	01961 Varian Associates Inc. Pulse Engineering Div. Convoy, CT	03877 Gilbert Engineering Co. Inc Incon Sub of Transatron Electronic Corp. Glendale, AZ	05277 Westinghouse Elec. Corp. Semiconductor Div. Youngwood, PA
0FB81 S-Mos Systems Inc. San Jose, CA	01963 Cherry Electrical Products Corp Waukegan, IL	03888 KDI Electronics Inc. Pyrofilm Div. Whippany, NJ	05347 Ultronix Inc Grand Junction, CO
0FFP1 Eveready LTD Ever Ready Special Battery Div. Dawley Telford Salop UK	02111 Spectrol Electronics Corp. City of Industry, CA	03911 Clairex Corp. Clairex Electronics Div. Mount Vernon, NY	05397 Union Carbide Corp. Materials Systems Div. Cleveland, OH
00199 Marcon Electronics Corp Keamy, NJ	02114 Ampere Electronic Corp. Ferrox Cube Div. Saugerties, NY	03980 Muirhead Inc. Mountainside, NJ	05571 Sprague Electric Co. (Now 56289)
00213 Nytronics Comp. Group Inc. Darlinton, NC	02131 General Instrument Corp. Government Systems Div. Westwood, MA	04009 Cooper Industries, Inc. Arrow Hart Div. Hartford, CT	05574 Viking Connectors Inc Sub of Ciron Corp. Chatsworth, CA
00327 Welwyn International Inc. Westlake, OH	02395 Sonar Radio Corp. Hollywood, FL	04217 Essex International Inc. Wire & Cable Div. Anaheim, CA	05791 LYN-TRON Burbank, CA
00656 Aerovox Corp. New Bedford, MA	02533 Leigh Instruments Ltd. Frequency Control Div. Don Mills, Ontario, Canada	04221 Midland-Ross Corp. Midtex Div. N. Mankato, MN	05820 EG & G Wakefield Engineering Wakefield, MA
00686 Film Capacitors Inc. Passaic, NJ	02606 Fenwal Labs Division of Travenal Labs Morton Grove, IL	04222 AVX Corp. AVX Ceramics Div. Myrtle Beach, SC	05839 Advance Electrical Chicago, IL
00779 AMP, Inc. Harrisburg, Pennsylvania	02660 Bunker Ramo-Eltra Corp. Amphenol NA Div. Broadview, IL	05972 Loctite Corp. Newington, CT	
00853 Sangamo Weston Inc Components Div Pickens, NC			
01091 Allied Plastics Co. Los Angeles, CA			

Federal Supply Codes for Manufacturers (cont)

06001 General Electric Co. Electric Capacitor Product Section Columbia, SC	07047 Ross Milton Co., The Southampton, PA	08111 MF Electronics New Rochelle, NY	1B715 (United Shoe & Nylock Corp) -Nylock Fastener Corp.- Paramus, NJ
06141 Fairchild Weston Systems Inc. Data Systems Div. Sarasota, FL	07138 Westinghouse Electric Corp. Industrial & Government Tube Div. Horseheads, NY	08235 Industro Transistor Corp. Long Island City, NY	10059 Barker Engineering Corp. Kenilworth, NJ
06192 La Deau Mfg. Co. Glendale, CA	07233 Benchmark Technology Inc. City of Industry, CA	08261 Spectra-Strip An Eltra Co. Garden Grove, CA	10389 IL Tool Works Inc. Licon Div. Chicago, IL
06229 Electrovert Inc. Elmsford, NY	07239 Biddle Instruments Blue Bell, PA	08445 Electri-Cord Mfg., Inc Westfield, PA	11236 CTS Corp. Resistor Products Div. Berne, IN
06383 Panduit Corp. Tinley Park, IL	07256 Silicon Transistor Corp. Sub of BBF Inc. Chelmsford, MA	08530 Reliance Mica Corp. Brooklyn, NY	11237 CTS Corp of CA Electro Mechanical Div. Paso Robles, CA
06473 Bunker Ramo Corp. Amphenol NA Div. SAMS Operation Chatsworth, CA	07261 Avnet Corp. Culver City, CA	08718 ITT Cannon Electric Phoenix Div. Phoenix, AZ	11295 ECM Motor Co. Schaumburg, IL
06540 Mite Corp Amatom-Electrical Div	07263 Fairchild Semiconductor North American Sales Ridgeview, CT	08806 General Electric Co. Minature Lamp Products Cleveland, OH	11358 Columbia Broadcasting System CBS Electronic Div. Newburyport, MA
06555 Beede Electrical Instrument Penacook, NH	07344 Bircher Co. Inc., The Rochester, NY	08863 Nylomatic Fallsington, PA	11403 Vacuum Can Co. Best Coffee Maker Div. Chicago, IL
06665 Precision Monolithics Sub of Boums Inc. Santa Clara, CA	07374 Optron Corp Woodbridge, CT	08988 Skottie Electronics Inc. Archbald, PA	11502 (can also use 35009) TRW Inc. TRW Resistive Products Div. Boone, NC
06666 General Devices Co. Inc. INpolis, IN	07557 Campion Co. Inc. Philadelphia, PA	09021 Airco Inc. Airco Electronics Bradford, PA	11503 Keystone Columbia Inc. Freemont, IN
06739 Electron Corp. Littleton, CO	07597 Bumdy Corp. Tape/Cable Div. Rochester, NY	09023 Cornell-Dublier Electronics Fuquay-Varina, NC	11532 Teledyne Relays Teledyne Industries Inc. Hawthorne, CA
06743 Gould Inc. Foil Div. Eastlake, OH	07716 TRW Inc. (Can use 11502) IRC Fixed Resistors/ Burlington Burlington, VT	09214 General Electric Co. Semiconductor Products Dept. Auburn, NY	11711 General Instrument Corp. Rectifier Div. Hicksville, NY
06751 Components Inc. Semcor Div. Phoenix, AZ	07792 Lerma Engineering Corp. Northampton, MA	09353 C and K Components Inc. Newton, MA	11726 Qualidyne Corp. Santa Clara, CA
06776 Robinson Nugent Inc. New Albany, IN	07810 Bock Corp. Madison, WI	09423 Scientific Components Inc. Santa Barbara, CA	12014 Chicago Rivet & Machine Co. Naperville, IL
06915 Richco Plastic Co. Chicago, IL	07910 Teledyne Semiconductor Mtn. View, CA	09922 Bumdy Corp. Norwalk, CT	12020 Ovenaire Div. of Electronic Technologies Charlottesville, VA
06961 Vernitron Corp. Piezo Electric Div. Bedford, OH	07933 Raytheon Co. Semiconductor Div. Mountain View, CA	09969 Dale Electronics Inc. Yankton, SD	12038 Simco (Div of Ransburg Corp) Hatfield, PA
06980 EIMAC (See Varian) San Carlos, CA	08FG6 Calmos Systems Inc. Kanata, Ont. Canada	09975 Burroughs Corp. Electronics Components Detroit, MI	12040 National Semiconductor Corp. Danbury, CT
	080A9 Dallas Semiconductor Dallas, TX	1A791 LFE Electronics Danvers, MA	

Federal Supply Codes for Manufacturers (cont)

12060 Diodes Inc. Northridge, CA	13050 Potter Co. Wesson, MS	14704 Crydom Controls (Division of Int Rectifier) El Segundo, CA	16473 Cambridge Scientific Industries Div. of Chemed Corp. Cambridge, MD
12136 PHC Industries Inc. Formerly Philadelphia Handle Co. Camden, NJ	13103 Thermalloy Co., Inc. Dallas, TX	14752 Electro Cube Inc. San Gabriel, CA	16733 Cablewave Systems Inc. North Haven, CT
12300 AMF Canada Ltd. Potter-Brumfield Guelph, Ontario, Canada	13327 Solitron Devices Inc. Tappan, NY	14936 General Instrument Corp. Discrete Semi Conductor Div. Hicksville, NY	16742 Paramount Plastics Fabricators Inc. Downey, CA
12323 Practical Automation Inc. Shelton, CT	13511 Bunker-Ramo Corp. Amphenol Cadre Div. Los Gatos, CA	14949 Trompeter Electronics Chatsworth, CA	16758 General Motors Corp. Delco Electronics Div. Kokomo, IN
12327 Freeway Corp. Cleveland, OH	13606 Sprague Electric Co. (Use 56289)	15412 Amtron Midlothian, IL	17069 Circuit Structures Lab Burbank, CA
12406 Elpac Electronics Inc. Santa Ana, CA	13689 SPS Technologies Inc. Hatfield, NJ	15542 Scientific Components Corp. Mini-Circuits Laboratory Div. Brooklyn, NY	17117 Electronic Molding Corp. Woonsocket, RI
12443 Budd Co.,The Plastics Products Div. Phoenixville, PA	13764 Micro Plastics Flippin, AZ	15636 Elec-Trol Inc. Saugus, CA	17338 High Pressure Eng. Co. Inc. OK City, OK
12581 Hitachi Metals International Ltd. Hitachi Magna-Lock Div. Big Rapids, MO	13919 Burr-Brown Research Corp. Tucson, AZ	15782 Bausch & Lomb Inc. Graphics & Control Div. Austin, TX	17504 Aluminum Filter Co. Carpinteria, CA
12615 US Terminals Inc. Cincinnati, OH	14099 Semtech Corp. Newbury Park, CA	15801 Fenwal Electronics Inc. Div. of Kidde Inc. Framingham, MA	17545 Atlantic Semiconductors Inc. Asbury Park, NJ
12617 Hamlin Inc. LaKe Mills, WI	14140 McGray-Edison Co. Commercial Development Div. Manchester, NH	15818 Teledyne Inc. Co. Teledyne Semiconductor Div. Mountain View, CA	17745 Angstrohm Precision, Inc. Hagerstown, MD
12673 Wesco Electrical Greenfield, MA	14189 Ortronics, Inc. Orlando, FL	15849 Usecro Inc. (Now 88245)	17856 Siliconix Inc. Santa Clara, CA
12697 Clarostat Mfg. Co. Inc. Dover, NH	14193 Cal-R-Inc. Santa Monica, CA	15898 International Business Machines Corp. Essex Junction, VT	18178 E G & Gvactee Inc. St. Louis, MO
12749 James Electronic Inc. Chicago, IL	14301 Anderson Electronics Hollidaysburg, PA	16068 International Diode Div. Harrison, NJ	18235 KRL/Bantry Components Inc. Manchester, NH
12856 MicroMetals Inc. Anaheim, CA	14329 Wells Electronics Inc. South Bend, IN	16162 MMI Southfield, MI	18310 Concord Electronics New York, NY
12881 Metex Corp. Edison, NJ	14482 Watkins-Johnson Co. Palo Alto, CA	16245 Conap Inc. Olean, NY	18324 Signetics Corp. Sacramento, CA
12895 Cleveland Electric Motor Co. Cleveland, OH	14552 Microsemi Corp. (Formerly Micro-Semiconductor) Santa Ana, CA	16258 Space-Lok Inc. Burbank, CA	18377 Parlex Corp. Methuen, MA
12954 Microsemi Corp. Components Group Scottsdale, AZ	14604 Elmwood Sensors, Inc Pawtucket, RI	16352 Codi Corp. Linden, NJ	18520 Sharp Electronics Corp. Paramus, NJ
12969 Unitrode Corp. Lexington, MA	14655 Cornell-Dublier Electronics Div. of Federal Pacific Electric Co. Govt Cont Dept. Newark, NJ	16469 MCL Inc. LaGrange, IL	18542 Wabash Inc. Wabash Relay & Electronics Div. Wabash, IN

Federal Supply Codes for Manufacturers (cont)

18565 Chomerics Inc. Woburn, MA	2Y384 North American Philips Lighting Corp. Van Wert, OH	23732 Tracor Applied Sciences Inc. Rockville, MD	26402 Lumex, Inc. Bayshore, NY
18612 Vishay Intertechnology Inc. Vishay Resistor Products Group Malvern, PA	20584 Enochs Mfg. Inc. INpolis, IN	23880 Stanford Applied Engineering Santa Clara, CA	26629 Frequency Sources Inc. Sources Div. Chelmsford, MA
18632 Norton-Chemplast Santa Monica, CA	20891 Cosar Corp. Dallas, TX	23936 William J. Purdy Co. Pamotor Div. Burlingame, CA	26806 American Zettler Inc. Irvine, CA
18677 Scanbe Mfg. Co. Div. of Zero Corp. El Monte, CA	21317 Electronics Applications Co. El Monte, CA	24347 Penn Engineering Co. S. El Monte, CA	27014 National Semiconductor Corp. Santa Clara, CA
18736 Voltronics Corp. East Hanover, NJ	21604 Buckeye Stamping Co. Columbus, OH	24355 Analog Devices Inc. Norwood, MA	27167 Corning Glass Works Corning Electronics Wilmington, NC
18786 Micro-Power Long Island City, NY	21845 Solitron Devices Inc. Semiconductor Group Riviera Beach, FL	24444 General Semiconductor Industries, Inc. Tempe, AZ	27264 Molex Inc. Lisle, IL
18927 GTE Products Corp. Precision Material Products Business Parts Div. Titusville, PA	21847 Aertech Now TRW Microwave Inc. Sunnyvale, CA	24546 Bradford Electronics Bradford, PA	27440 Industrial Screw Products Los Angeles, CA
19080 Robinson Electronics Inc. San Luis Obispo, CA	21962 Vectron Corp. Replaced by: S.W. Electronics	24618 Transcon Mfg. Now: D.J. Associates Inc.	27494 Staffall, Inc. Providence, RI
19112 Garry Corp. Langhorne, PA	22526 DuPont, El DeNemours & Co. Inc. DuPont Connector Systems Advanced Products Div. New Cumberland, PA	24655 Genrad Inc. (Replaced General Radio 05173) Concord, MA	27745 Associated Spring Bames Group Inc. Syracuse, NY
19315 Bendix Corp., The Navigation & Control Group Terboro, NJ	22626 Micro Semiconductor (Now 14552)	24759 Lenox-Fugle Electronics Inc. South Plainfield, NJ	27918 Component Parts Corp. Bellmore, NY
19451 Perine Machine Tool Corp. Kent, WA	22670 GM Nameplate Seattle, WA	24796 AMF Inc. Potter & Brumfield Div. San Juan Capistrano, CA	27956 Relcom (Now 14482)
19482 Delta Electronics Alexandria, VA	22767 ITT Semiconductors Palo Alto, CA	24931 Specialty Connector Co. Greenwood, IN	28175 Alpha Metals Chicago, IL
19613 MN Mining & Mfg. Co. Textool Products Dept. Electronic Product Div. Irving, TX	22784 Palmer Inc. Cleveland, OH	24995 ECS Grants Pass, OR	28198 Positronic Industries Springfield, MO
19647 Caddock Electronics Inc. Riverside, CA	23050 Product Comp. Corp. Mount Vernon, NY	25088 Siemen Corp. Isilen, NJ	28213 MN Mining & Mfg. Co. Consumer Products Div. 3M Center Saint Paul, MN
19701 Mepco/Centralab Inc. A. N. American Phillips Co. Mineral Wells, TX	23223 CTS Microelectronics Lafayette, NY	25099 Cascade Gasket Kent, WA	28309 Kaiser Minette, AL
2B178 Wire Products Cleveland, OH	23237 I.R.C., Inc. Microcircuits Division Philadelphia, PA	25403 Amperex Electronic Corp. Semiconductor & Micro-Circuit Div. Slatersville, RI	28425 Serv-O-Link Eulless, TX
2K262 Boyd Corporation Portland, OR	23302 S.W. Electronics & Mfg. Corp. Cherry Hill, NJ	25435 Moldtronics, Inc Downers Grove, IL	28478 Deltrol Corporation Deltrol Controls Div. Milwaukee, WI
	23730 Mark Eyelet and Stamping Inc. Wolcott, CT	25706 Dabum Electronic & Cable Corp. Norwood, NJ	28480 Hewlett Packard Co. Corporate HQ Palo Alto, CA

Federal Supply Codes for Manufacturers (cont)

28484 Emerson Electric Co. Gearmaster Div. McHenry, IL	31433 Kemet Electronics Corp. Simpsonville, NC	33246 Epoxy Technology Inc. Billerica, MA	36701 Van Waters & Rogers Valley Field, Quebec, Canada
28520 Heyco Molded Products Kenilworth, NJ	31448 Army Safeguard Logistics Command Huntsville, AL	33292 Pioneer Sterilized Wiping Cloth Co. Portland, OR	37942 Mallory Capacitor Corp. Sub of Emhart Industries INpolis, IN
28932 Lumax Industrials, Inc Altoona, PA	31471 Gould Inc Semiconductor Div Santa Clara, CA	33297 NEC Electronics USA Inc. Electronic Arrays Inc. Div. Mountain View, CA	39003 Maxim Industries Middleboro, MA
29083 Monsanto Co. Santa Clara, CA	31522 Metal Masters Inc. Baldwin, MS	33919 Nortek Inc. Cranston, RI	4F434 Plastic Sales Los Angeles, CA
29604 Stackpole Components Co. Raleigh, NC	31746 Cannon Electric Woodbury, TN	34114 Oak Industries Rancho Bernardo, CA	40402 Roderstein Electronics Inc. Statesville, NC
29907 Omega Engineering Inc. Stamford, CT	31827 Budwig Ramona, CA	34263 CTS Electronics Corp. Brownsville, TX	42498 National Radio Melrose, MA
3D536 Aimco Inc. Seattle, WA	31918 ITT-Schadow Eden Prairie, MN	34333 Silicon General Inc. Garden Grove, CA	43543 Nytronics Inc.(Now 53342)
30035 Jolo Industries Inc. Garden Grove, CA	32293 Intersil Cupertino, CA	34335 Advanced Micro Devices (AMD) Sunnyvale, CA	43744 Panasonic Industrial Co. San Antonio, TX
30045 Solid Power Corp. Farmingdale, NY	32539 Mura Corp. Westbury, Long Island, N.Y.	34359 MN Mining & Mfg. Co. Commercial Office Supply Div. Saint Paul, MN	43791 Datron Systems Wilkes Barre, PA
30146 Symbex Corp. Painesville, OH	32559 Bivar Santa Ana, CA	34371 Harris Corp. Harris Semiconductor Products Group Melbourne, FL	44655 Ohmite Mfg. Co. Skokie, IL
30148 AB Enterprise Inc. Ahoskie, NC	32719 Siltronics Santa Ana, CA	34576 Rockwell International Corp. Newport Beach, CA	47001 Lumberg Inc. Richmond, VA
30161 Aavid Engineering Inc. Laconia, NH	32767 Griffith Plastics Corp. Burlingame, CA	34641 Instrument Specialties Eulless, TX	47379 ISOCOM Campbell, CA
30315 Itron Corp. San Diego, CA	32879 Advanced Mechanical Components Northridge, CA	34649 Intel Corp. Santa Clara, CA	49569 IDT (International Development & Trade) Dallas, TX
30323 IL Tool Works Inc. Chicago, IL	32897 Murata Erie North America Inc. Carlisle Operations Carlisle, Pennsylvania	34802 Electromotive Inc. Kenilworth, NJ	49671 RCA Corp. New York, NY
30800 General Instrument Corp. Capacitor Div. Hicksville, NY	32997 Bourns Inc. Trimpot Div. Riverside, CA	34848 Hartwell Special Products Placentia, CA	49956 Raytheon Company Executive Offices Lexington, MA
30838 Fastec Chicago, ILL	33025 M/A ComOmni Spectra, Inc. (Replacing Omni Spectra) Microwave Subsystems Div. Tempe, AZ	35009 Renfrew Electric Co. Ltd. IRC Div. Toronto, Ontario, Canada	5D590 Mostek Corp. Replaced by: SGS Thompson Microelec- tronics
31019 Solid State Scientific Inc. Willow Grove, PA	33096 CO Crystal Corp. Loveland, CO	35986 Amrad Melrose Park, IL	5F520 Panel Components Corp. Santa Rosa, CA
31091 Alpha Industries Inc. Microelectronics Div. Hatfield, PA	33173 General Electric Co. Owensboro, KY	36665 Mitel Corp. Kanata, Ontario, Canada	5P575 Nobel Electronics Suffern, NY
31323 Metro Supply Company Sacramento, CA			5W664 NDK Div. of Nihon Dempa Kogyo LTD Lynchburg, VA

Federal Supply Codes for Manufacturers (cont)

5U802 Dennison Mfg. Co. Framingham, MA	51499 Amtron Corp. Boston, MA	52840 Western Digital Corp. Costa Mesa, CA	54937 DeYoung Mfg. Bellevue, WA
50088 SGS - Thomson Microelectronics Inc. Carrollton, TX	51506 Accurate Screw Machine Co. (ASMCO) Nutley, NJ	53021 Sangamo Weston Inc. (See 06141)	54590 RCA Corp. Electronic Components Div. Cherry Hill, NJ
50120 Eagle-Picher Industries Inc. Electronics Div. CO Springs, CO	51605 CODI Semiconductor Inc. Kenilworth, NJ	53036 Textool Co. Houston, TX	55026 American Gage & Machine Co. Simpson Electric Co. Div. Elgin, IL
50157 Midwest Components Inc. Muskegon, MS	51642 Centre Engineering Inc. State College, PA	53184 Xeiton Corp. Lathan, NY	55112 Plessey Capacitors Inc. (Now 60935)
50356 Teac Corp. of America Industrial Products Div Montebello, CA	51705 ICO/Rally Palo alto, CA	53217 Technical Wire Products Inc. Santa Barbara, CA	55261 LSI Computer Systems Inc. Melville, NY
50364 MMI, Inc. (Monolithic Memories Inc) Military Products Div. Santa Clara, CA	51791 Statek Corp. Orange, CA	53342 Opt Industries Inc. Phillipsburg, NJ	55285 Berequist Co. Minneapolis, MN
50472 Metal Masters, Inc. City of Industry, CA	51984 NEC America Inc. Falls Church, VA	53673 Thompson CSF Components Corp. (Semiconductor Div) Conaga Park, CA	55322 Samtech Inc. New Albany, IN
50541 Hypertronics Corp. Hudson, MA	52063 Exar Integrated Systems Sunnyvale, CA	53718 Airmold/W. R. Grese & Co. Roanoke Rapids, NC	55408 STI-CO Industries Co Buffalo, NY
50558 Electronic Concepts, Inc. Eatontown, NJ	52072 Circuit Assembly Corp. Irvine, CA	53848 Standard Microsystems Hauppauge, NY	55464 Central Semiconductor Corp. Hauppauge, NY
50579 Litronix Inc. Cupertino, CA	52152 MN Mining & Mfg. Saint Paul, MN	53894 AHAM Inc. RanchoCA, CA	55557 Microwave Diode Corp. W. Stewartstown, NH
50891 Semiconductor Technology Stuart, FL	52333 API Electronics Hauppauge, Long Island, NY	53944 Glow-Lite Pauls Valley, OK	55566 R A F Electronic Hardware Inc. Seymour, CT
50934 Tran-Tec Corp Columbus, NE	52361 Communication Systems Piscataway, NJ	54178 Plasmetex Industries Inc. San Marcos, CA	55576 Synertek Santa Clara, CA
51167 Aries Electronics Inc. Frenchtown, NJ	52500 Amphenol, RF Operations Burlington, MA	54294 Shallcross Inc. Smithfield, NC	55680 Nichicon/America/Corp. Schaumburg, IL
51284 Mos Technology Norristown, PA	52525 Space-Lok Inc. Lerco Div. Burbank, CA	54453 Sullins Electronic Corp. San Marcos, CA	55943 D J Associates, Inc (Replaced Transcon Mfg.-24618) Fort Smith, AZ
51249 Heyman Mfg. Co. Cleveland, OH	52531 Hitachi Magnetics Edmore, MO	54473 Matsushita Electric Corp. (Panasonic) Secaucus, NJ	56282 Utek Systems Inc. Olathe, KS
51372 Verbatim Corp. Sunnyvale, CA	52745 Timco Los Angeles, CA	54492 Cinch Clamp Co., Inc. Santa Rosa, CA	56289 Sprague Electric Co. North Adams, MA
51398 MUPAC Corp. Brockton, MA	52763 Stettner-Electronics Inc. Chattanooga, TN	54583 TDK Garden City, NY	56365 Square D Co. Corporate Offices Palatine, IL
51406 Murata Erie, No. America Inc. (Also see 72982) Marietta, GA	52769 Sprague-Goodman Electronics Inc. Garden City Park, NY	54590 RCA Corp Distribution & Special Products Cherry Hill, NY	56375 WESCORP Div. Dal Industries Inc Mountain View, CA
	52771 Moniterm Corp. Amatrom Div. Santa Clara, CA	54869 Piher International Corp. Arlington Heights, IL	

Federal Supply Codes for Manufacturers (cont)

56481 Shugart Associates Sub of Xerox Corp. Sunnyvale, CA	59610 Souriau Inc Valencia, CA	60911 Inmos Corp. CO Springs, CO	64537 KDI Electronics Whippany, NJ
56637 RCD Components Inc. Manchester, NH	59635 HV Component Associates Howell, NJ	60935 Westlake Capacitor Inc. Tantum Div. Greencastle, IN	64782 Precision Control Mfg. Inc. Bellevue, WA
56708 Zilog Inc. Campbell, CA	59640 Supertex Inc. Sunnyvale, CA	60958 ACIC Intercomp Wire & Cable Div. Hayesville, NC	64834 West M G Co. San Francisco, CA
56856 Vamistor Corp. of TN Sevierville, TN	59660 Tusonix Inc. Tucson, AZ	61271 Fujitsu Microelectronics Inc San Jose, CA	64961 Electronic Hardware LTD North Hollywood, CA
56880 Magnetics Inc. Baltimore, MD	59730 Thomas and Betts Corp. IA City, IA	61394 SEEQ Technology Inc. San Jose, CA	65092 Sangamo Weston Inc. Weston Instruments Div. Newark, NJ
57026 Endicott Coil Co. Inc. Binghamton, NY	59831 Semtronics Corp. Watchung, NJ	61429 Fox Electronics Cape Coral, FL	65786 Cypress Semi San Jose, CA
57053 Gates Energy Products Denver, CO	61053: American Components Inc. an Insilco Co. RPC Div. Hayesville, NC	61529 Aromat Corp. New Providence, NJ	65940 Rohm Corp & Whatney Irvine, CA
57170 Cambridge Thermionic Cambridge, MA Replaced by: 71279 Interconnection Products Inc.	61611 Allen, Robert G. Inc. Van Nuys, CA	61752 IR-ONICS Inc Warwick, RI	65964 Evon Inc. Bannockburn, IL
57668 R-ohm Corp Irvine, CA	61850 Burgess Switch Co., Inc Northbrook, IL	61772 Integrated Device Technology Santa Clara, CA	66150 Entron Inc. Winslow Teltronics Div. Glendale, NY
57962 SGS - Thomson Microelectronics Inc Montgomeryville, PA	61095 AMD Enterprises, Inc. Roswell, GA	61802 Toshiba Houston, TX	66302 VLSI Technology Inc. San Jose, CA
58014 Hitachi Magnalock Corp. (Now 12581)	61403 SGS/ATES Semiconductor Corp. INpolis, IN	61857 SAN-O Industrial Corp. Bohemia, Long Island, NY	66419 Exel San Jose, CA
58104 Simco Atlanta, GA	61440 Micon Technology Inc. Boise, ID	61935 Schurter Inc. Petaluma, CA	66450 Dyna-Tech Electronics, Inc Walled Lake, MI
58364 BYCAP Inc. Chicago, IL	61046 Power Dynamics Inc West Orange, NJ	62351 Apple Rubber Lancaster, NY	66608 Bering Industries Freemont, CA
58451 Precision Lamp Cotat, CA	61097 Precicontact Inc. Langhorne, PA	62643 United Chemicon Rosemont, IL	66891 BKC International Electronics Lawrence, MA
58474 Superior Electric Co. Bristol, CT	61086 Squires Electronics Inc Cornelius, OR	62712 Seiko Instruments Torrance, CA	66958 SGS Semiconductor Corp. Phoenix, AZ
58614 Communications Instruments Inc. Fairview, NC	61095 Xicor Inc. Milpitas, CA	62793 Lear Siegler Inc. Energy Products Div. Santa Ana, CA	66967 Powerex Inc Auburn, NY
59124 KOA-Speer Electronics Inc. Bradford, PA	61099 Torin Engineered Blowers Div. of Clevepak Corp. Torrington, CT	63743 Ward Leonard Electric Co.Inc. Mount Vernon, NY	67183 Altera Santa Clara, CA
59422 Holmberg Electronics Irvine, CA	61496 Micrel Inc. Sunnyvale, CA	64154 Lamb Industries Portland, OR	68919 WIMA % Harry Levinson Co. Seattle, WA
	61075 Cera-Mite Corp. (formerly Sprague) Grafton, WI	64155 Linear Technology Milpitas, CA	

Federal Supply Codes for Manufacturers (cont)

7F361 Richmond-Division of Dixico % Zellerbach Paper Co. Seattle, WA	71468 ITT Cannon Div. of ITT Fountain Valley, CA	73138 Beckman Industrial corp. Helipot Div. Fullerton, CA	75042 TRW Inc. IRC Fixed Resistors Philadelphia, PA
7F844 Moore Business Forms, Inc Seattle, WA	71482 General Instrument Corp. Clare Div. Chicago, IL	73168 Fenwal Inc. Ashland, MA	75297 Kester Solder Div. Litton Systems, Inc Des Plaines, IL
7G902 Textron Inc. Camcar Div. Rockford, IL	71590 Mepco/Centralab A North American Philips Co. Fort Dodge, IA	73293 Hughes Aircraft Co. Electron Dynamics Div. Torrance, CA	75376 Kurz-Kasch Inc. Dayton, OH
7J395 Universal Plastics Welshpool, WA	71707 Coto Corp. Providence, RI	73445 Amperex Electronic Corp. Hicksville, NY	75378 CTS Knights Inc. Sandwich, IL
7J696 AMD Plastics East Lake, OH	71744 General Instrument Corp. Lamp Div/Worldwide Chicago, IL	73559 Carlingswitch Inc. Hartford, CT	75382 Kulka Electric Corp. (Now 83330) Mount Vernon, NY
7K354 Omni Spectra Inc Los Altos, CA	71785 TRW Inc. Cinch Connector Div. Elk Grove Village, IL	73586 Circle F Industries Trenton, NJ	75569 Performance Semiconductor Corp. Sunnyvale, CA
7Z884 ALPS Seattle, WA	71984 Dow Coming Corp. Midland, MI	73734 Federal Screw Products Inc. Chicago, IL	75915 Littelfuse Tracor (Formerly: Tracor-Littelfuse) Des Plaines, IL
7X634 Duracell USA Div. of Dart & Kraft Inc. Valdese, NC	72005 AMAX Specialty Metals Corp. Newark, NJ	73743 Fischer Special Mfg. Co. Cold Spring, KY	76854 Oak Switch Systems Inc. Crystal Lake, IL
70290 Almetal Universal Joint Co. Cleveland, OH	72136 Electro Motive Mfg. Corp. Florence, NC	73893 Microdot Mt. Clemens, MS	77122 TRW Assemblies & Fasteners Group Fastener Div. Moutainside, NJ
70485 Atlantic India Rubber Works Inc. Chicago, IL	72228 AMCA International Corp. Continental Screw Div. New Bedford, MA	73899 JFD Electronic Components Div. of Murata Erie Oceanside, NY	77342 AMF Inc. Potter & Brumfield Div. Princeton, IN
70563 Amperite Company Union City, NJ	72259 Nytronics Inc. New York, NY	73905 FL Industries Inc. San Jose, CA	77542 Ray-O-Vac Corp Madison, WI
70903 Cooper-Belden Corp. Geneva, IL	72619 Amperex Electronic Corp. Dialight Div. Brooklyn, NY	73949 Guardian Electric Mfg. Co. Chicago, IL	77638 General Instrument Corp. Rectifier Div. Brooklyn, NY
71002 Bimbach Co. Inc. Farmingdale, NY	72653 G C Electronics Co. Div. of Hydrometals Inc. Rockford, IL	74199 Quam Nichols Co. Chicago, IL	77900 Shakeproof Lock Washer Co. (Now 78189)
71034 Bliley Electric Co. Erie, PA	72794 Dzus Fastner Co. Inc. West Islip, NY	74217 Radio Switch Co. Marlboro, NJ	77969 Rubbercraft Corp. of CA Ltd. Torrance, CA
71183 Westinghouse Electric Corp. Bryant Div. Bridgeport, CT	72928 Gulton Industries Inc. Gudeman Div. Chicago, IL	74306 Piezo Crystal Co. Div. of PPA Industries Inc. Carlisle, PA	78189 IL Tool Works Inc. Shakeproof Div. Elgin, IL
71279 Interconnection Products Inc. Formerly Midland-Ross Cambion Div. Santa Ana, CA	72962 Elastic Stop Nut Div. of Hamard Industries Union, NJ	74445 Holo-Krome Co. Elmwood, CT	78277 Sigma Instruments Inc. South Braintree, MA
71400 Bussman Manufacturing Div. McGraw-Edison Co. St. Louis, MO	72982 Erie Specialty Products, Inc Formerly: Murata Erie Erie, PA	74542 Hoyt Elect.Instr. Works Inc. Penacook, NH	78290 Struthers Dunn Inc. Pitman, NJ
71450 CTS Corp. Elkhart, IN		74840 IL Capacitor Inc. Lincolnwood, IL	78553 Eaton Corp. Engineered Fastener Div. Cleveland, OH
		74970 Johnson EF Co. Waseca, MN	

Federal Supply Codes for Manufacturers (cont)

78592 Stoeger Industries South Hackensack, NJ	81439 Therm-O-Disc Inc. Mansfield, OH	83315 Hubbell Corp. Mundelein, IL	87034 Illuminated Products Inc. (Now 76854)
79497 Western Rubber Co. Goshen, IN	81483 International Rectifier Corp. Los Angeles, CA	83330 Kulka Smith Inc. A North American Philips Co. Manasquan, NJ	87516 Standard Crystal KS City, KS
79727 C - W Industries Southampton, PA	81590 Korrey Electronics Inc. Seattle, WA	83478 Rubbercraft Corp. of America West Haven, CT	88044 Aeronautical Standards Group Dept. of Navy & Air Force
79963 Zierick Mfg. Corp. Mount Kisco, NY	81741 Chicago Lock Co. Chicago, IL	83553 Associated Spring Barnes Group Gardena, CA	88219 GNB Inc. Industrial Battery Div. Langhorne, PA
8C798 Ken-Tronics, Inc. Milan, IL	82227 Airtax Corp. Cheshire Div. Cheshire, CT	83740 Union Carbide Corp. Battery Products Div. Danbury, CT	88245 Winchester Electronics Litton Systems-Usecos Div. Van Nuys, CA
8D528 Baumgartens Atlanta, GA	82240 Simmons Fastener Corp. Albany, NY	84171 Arco Electronics Commack, NY	88486 Triangle PWC Inc. Jewett City, CT
8F330 Eaton Corp. Cutler Hammer Product Sales Office Mountain View, CA	82305 Palmer Electronics Corp. South Gate, CA	84411 American Shizuki TRW Capacitors Div. Ogallala, NE	88690 Essex Group Inc. Wire Assembly Div. Dearborn, MI
8T100 Tellabs Inc. Naperville, IL	82389 Switchcraft Inc. Sub of Raytheon Co. Chicago, IL	84613 FIC Corp. Rockville, MD	88786 Atlantic India Rubber Co. Goshen, IN
80009 Tektronix Beaverton, OR	82415 Airtax Corp. Frederick Div. Frederick, MD	84682 Essex Group Inc. Peabody, MA	88978 Philips (Now Fluke) Mahwah, NJ
80031 Mepco/Electra Inc. Morristown, NJ	82872 Roanwell Corp. New York, NY	84830 Lee Spring Co. Inc. Brooklyn, NY	89020 Amerace Corp. Buchanan Crimp Tool Products Div. Union, NJ
80032 Ford Aerospace & Communications Corp. Western Development Laboratories Div. Palo Alto, CA	82877 Rotron Inc. Custom Div. Woodstock, NY	85367 Bearing Distributing Co. San Francisco, CA	89265 Potter-Brumfield (See 77342)
80145 LFE Corp. Process Control Div. Clinton, OH	82879 ITT Royal Electric Div. Pawtucket, RI	85372 Bearing Sales Co. Los Angeles, CA	89462 Waldes Truarc, Inc. Long Island, NY
80183 Sprague Products (Now 56289)	83003 Varo Inc. Garland, TX	85480 W. H. Brady Co. Industrial Product Milwaukee, WI	89536 John Fluke Mfg. Co., Inc. Everett, WA
80294 Boums Instruments Inc. Riverside, CA	83014 Hartwell Corp. Placentia, CA	85840 Brady WH Co Industrial Products Div Milwaukee, WI	89597 Fredericks Co. Huntingdon Valley, PA
80583 Hammerlund Mfg. Co. Inc. Paramus, NJ	83055 Signalite Fuse Co. (Now 71744)	85932 Electro Film Inc. Valencia, CA	89709 Bunker Ramo-Eltra Corp. Amphenol Div. Broadview, IL
80640 Computer Products Inc. Stevens-Arnold Div. South Boston, MA	83058 TRW Assemblies & Fasteners Group Fasteners Div. Cambridge, MA	86577 Precision Metal Products Co. Peabody, MA	89730 General Electric Lamp Div. Newark, NJ
81073 Grayhill Inc. La Grange, IL	83259 Parker-Hannifin Corp. O-Seal Div. Culver City, CA	86684 Radio Corp. of America (Now 54590)	9R216 Data Composition Svc, Inc Laurel, MD
81312 Litton Systems Inc. Winchester Electronics Div. Watertown, CT	83298 Bendix Corp. Electric & Fluid Power Div. Eatonville, NJ	86928 Seastrom Mfg. Co. Inc. Glendale, CA	9S171 Port Plastics Tukwila, WA

Federal Supply Codes for Manufacturers (cont)

9W423 Amatom El Mont, CA	91934 Miller Electric Co. Woonsocket, RI	95573 Campion Laboratories Inc. Detroit, MI	98278 Malco A Microdot Co. South Pasadena, CA
90201 Mallory Capacitor Co. Sub of Emhart Industries Inc. Indianapolis, IN	91967 National Tel-Tronics Div. of electro Audio Dynamics Inc Meadville, PA	95712 Bendix Corp. Electrical Comp. Div. Franklin, IN	98291 Sealectro Corp. BICC Electronics Trumbull, CT
90215 Best Stamp & Mfg. Co. KS City, MO	91984 Maida Development Co. Hampton, VA	95987 Weckesser Co. Inc. (Now 85480)	98372 Royal Industries Inc. (Now 62793)
90303 Duracell Inc. Technical Sales & Marketing Bethel, CT	91985 Norwalk Valve Co. S. Norwalk, CT	96733 SFE Technologies San Fernando, CA	98388 Lear Siegler Inc. Accurate Products Div. San Deigo, CA
91094 Essex Group Inc. Suflex/IWP Div. Newmarket, NH	92218 Wakefield Corp., The Wakefield, ME	96853 Gulton Industries Inc. Measurement & Controls Div. Manchester, NH	98978 IERC (International Electronic Research Corp.) Burbank, CA
91247 IL Transformer Co. Chicago, IL	92527 VTC Inc. Bloomington, MN	96881 Thomson Industries Inc. Port WA, NY	99120 Plastic Capacitors Inc. Chicago, IL
91293 Johanson Mfg. Co. Boonton, NJ	92607 Tensolite Co. Div. of Carlisle Corp. Buchanan, NY	97464 Industrial Retainer Ring Irvington, NJ	99217 Bell Industries Inc. Elect. Distributor Div. Sunnyvale, CA
91462 Alpha Industries Inc. Logansport, IN	92914 Alpha Wire Corp. Elizabeth, NJ	97525 EECO Inc. Santa Ana, CA	99378 ATLEE of DE Inc. N. Andover, MA
91502 Associated Machine Santa Clara, CA	93332 Sylvania Electric Products Semiconductor Products Div. Woburn, MA	97540 Whitehall Electronics Corp. Master Mobile Mounts Div. Fort Meyers, FL	99392 Mepco/Electra Inc. Roxboro Div. Roxboro, NC
91506 Augat Alcoswitch N. Andover, MA	94144 Raytheon Co. Microwave & Power Tube Div. Quincy, MA	97913 Industrial Electronic Hardware Corp. NY, NY	99515 Electron Products Inc. Div. of American Capacitors Duarte, CA
91507 Froeliger Machine Tool Co. Stockton, CA	94222 Southco Inc. Concordville, PA	97945 Pennwalt Corp. SS White Industrial Products Piscataway, NJ	99779 Bunker Ramo- Eltra Corp. Barnes Div. Lansdown, PA
91637 Dale Electronics Inc. Columbus, NE	94988 Wagner Electric Corp. Sub of McGraw-Edison Co. Whippany, NJ	97966 CBS Electronic Div. Danvers, MA	99800 American Precision Industries Delevan Div. East Aurora, NY
91662 Elco Corp. A Gulf Western Mfg. Co. Connector Div. Huntingdon, PA	95146 Alco Electronic Products Inc. Switch Div. North Andover, MA	98094 Machlett Laboratories Inc. Santa Barbara, CA	99942 Mepco/Centralab A North American Philips Co. Milwaukee, WI
91737 ITT Cannon/Gremar (Now 08718)	95263 Leecraft Mfg. Co. Long Island City, NY	98159 Rubber-Teck Inc. Gardena, CA	
91802 Industrial Devices Inc. Edgewater, NJ	95275 Vitramon Inc. Bridgeport, CT		
91833 Keystone Electronics Corp. NY, NY	95303 RCA Corp. Receiving Tube Div. Cincinnati, OH		
91836 King's Electronics Co. Inc. Tuckahoe, NY	95348 Gordo's Corp. Bloomfield, NJ		
91929 Honeywell Inc. Micro Switch Div. Freeport, IL	95354 Methode Mfg. Corp. Rolling Meadows, IL		

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Allmendstrasse 140
CH-8027 Zurich
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Appendix 7A

Manual Status Information

INTRODUCTION

To identify the configuration of the pcb's used in your instrument, refer to the revision letter (marked in ink) on the component side of each pcb assembly. Table 7A-1 defines the assembly revision levels documented in this manual.

NEWER INSTRUMENTS

As changes and improvements are made to the instrument, they are identified by incrementing the revision letter marked on the affected pcb assembly. These changes are documented on a supplemental change/errata sheet which, when applicable, is inserted at the front of the manual.

Table 7A-1. Manual Status and Backdating Information

Ref Or Option No.	Assembly Name	Fluke Part No.	PCB revision level documented in this manual.																	
			—	A	B	C	D	E	F	G	H	J	K	L	M	N	P			
A1	Main PCB Assembly	469312	●	●	●	+	+	+	+	+	+	+	+	+	+	X				
A2	Display PCB Assembly	464297	●	●	●	●	●	X												
A3	RTD PCB Assembly	469304	●	●	●	+	X													
-002	Output PCB Assembly	466144	●	○	+	+	+	+	+	+	+	+	+	+	+	X				
-004	IEEE-488 Interface PCB Assembly	778456	○	+	X															
-006	Limits PCB Assembly	466185	○	○	○	○	○	X												

X = The PCB revision levels documented in this manual.
 ○ = These revision letters were never used in the instrument.
 + = Revision not documented in this manual.
 — = No revision letter on the PCB.

Section 8
Schematic Diagrams

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8-5.	IEEE-488 Interface PCB Assembly	8-14
8-6.	Limits PCB Assembly	8-18
8-7.	Mnemonics	8-19

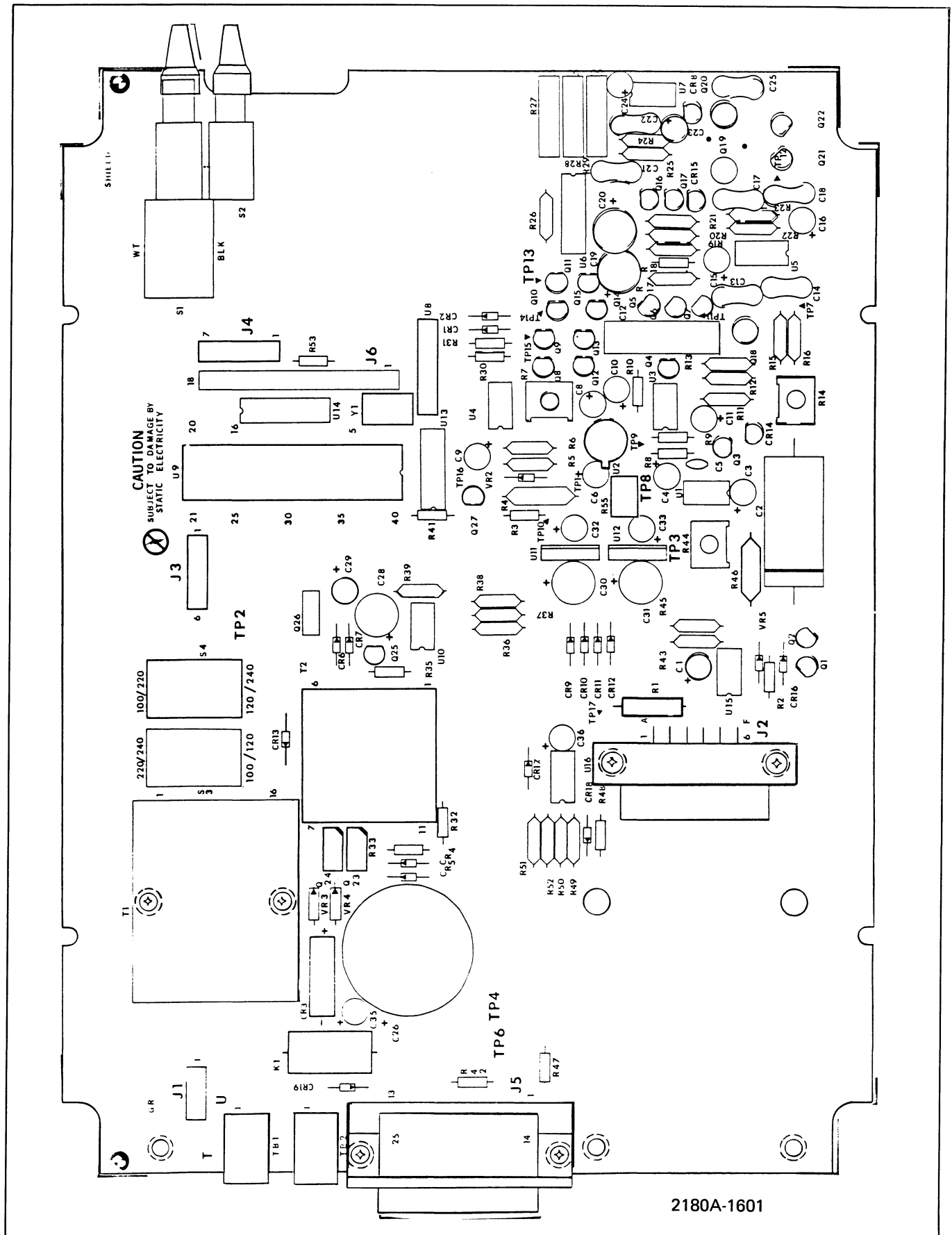
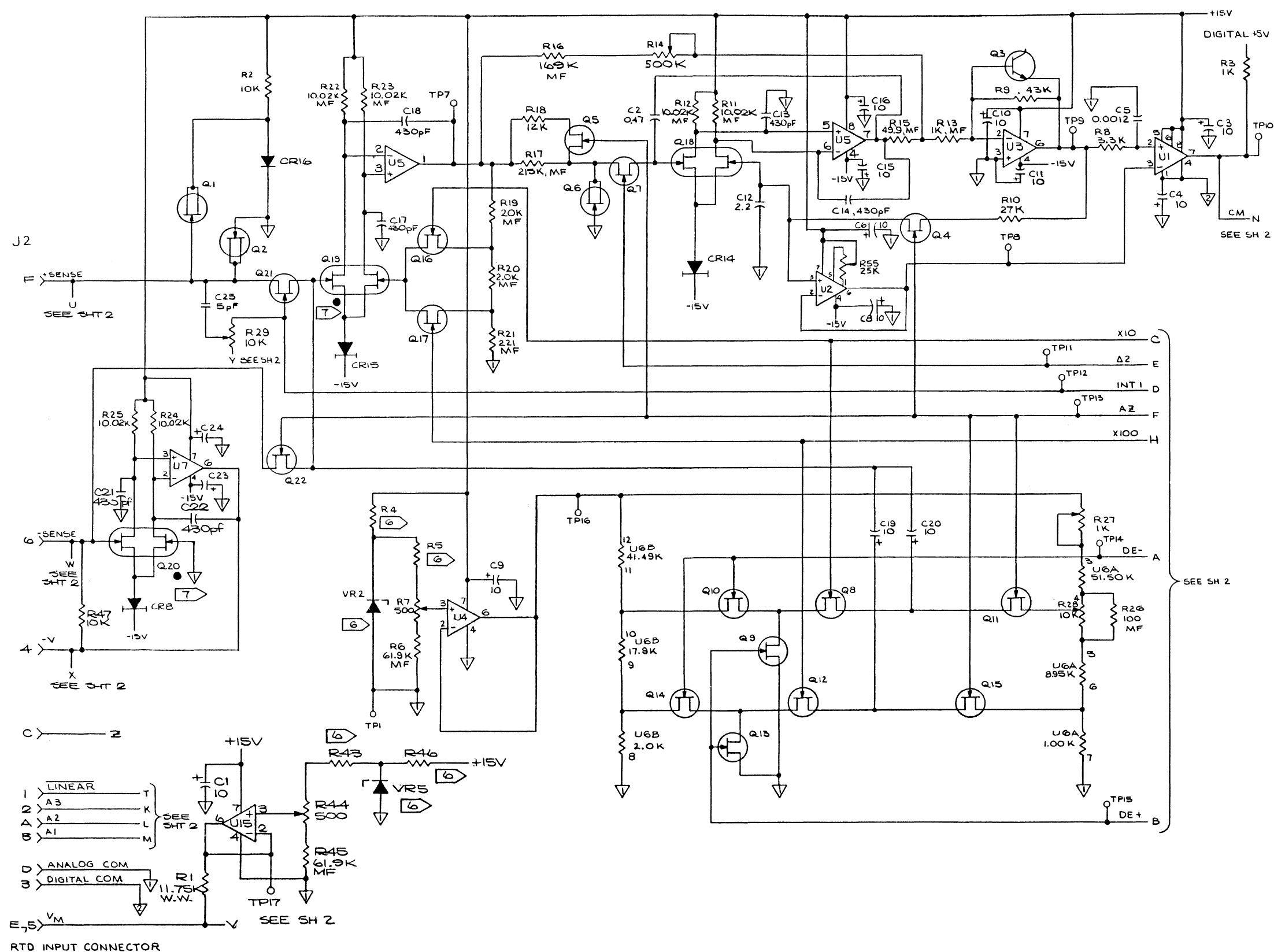





Figure 8-1. A1 Main PCB Assembly



NOTES:

1. UNLESS OTHERWISE SPECIFIED ALL RESISTANCES ARE IN OHMS AND ALL CAPACITANCES ARE IN MICROFARADS.
2. ALL RESISTORS ARE 1/4 W, 5% UNLESS OTHERWISE NOTED.
3. ALL GRAPHIC SYMBOLS ARE IN ACCORDANCE WITH ANSI Y32.2 AND Y32.14.
4.  DENOTES ANALOG COMMON. (0 VOLTS)
 DENOTES LOGIC COMMON, DIGITAL COMMON
IS -15V WITH RESPECT TO ANALOG COMMON.
 DENOTES EARTH COMMON

WARNING: DO NOT CONNECT ∇ TO ∇
DAMAGE MAY RESULT

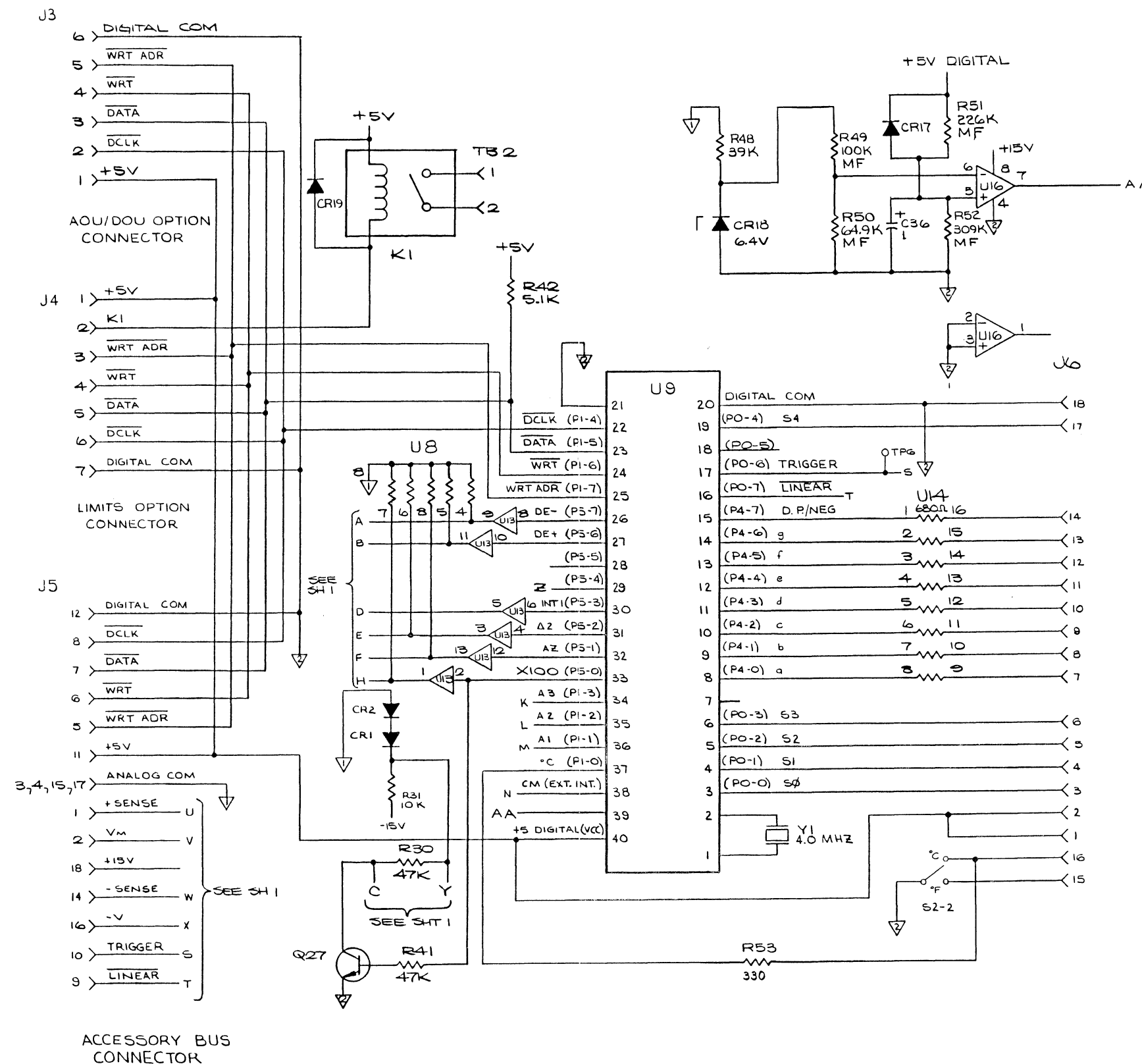
5. SELECTED SET
6. POSITION Q19 & Q20 WITH MARKED GATE IN POSITION SHOWN

REF DES.	+5 DIG.	+15 V	▽	▽
U1		5, 6, 8	1, 4	
U2		7	4	
U3		7	4	3
U4		7		4
U5		8	4	
U6				7, 8
U7		7	4	
U8				1
U9	40		20	
U10			4	
U11	14		7	
U14				
U15		7		4
U16		8	4, 2, 3	

REF DES	
LAST USED	NOT USED
CR19, R55, C36 U16, VR5, Q27, T2.	VR1, R54

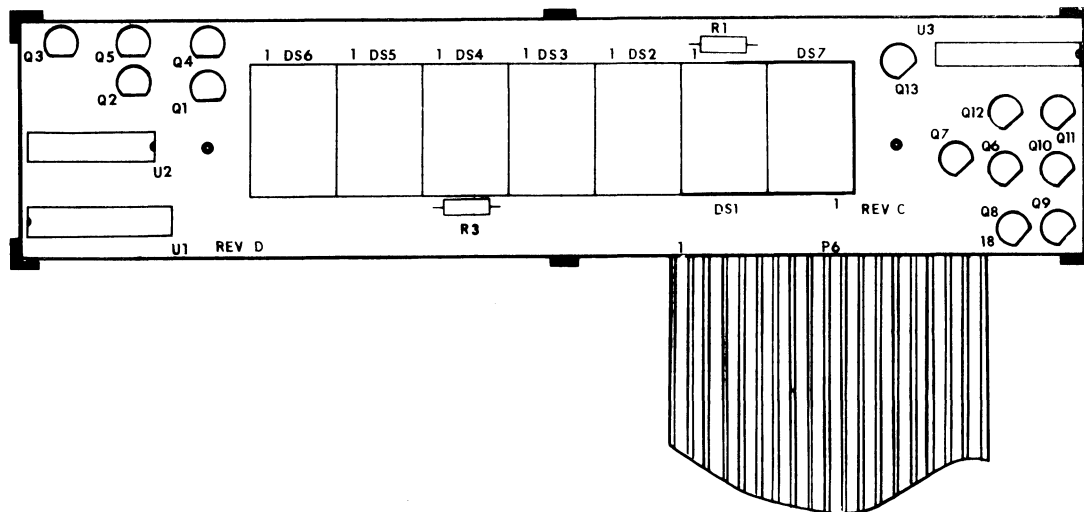
2180A-1001
(Sht 1 of 3)

Figure 8-1. A1 Main PCB Assembly (cont)



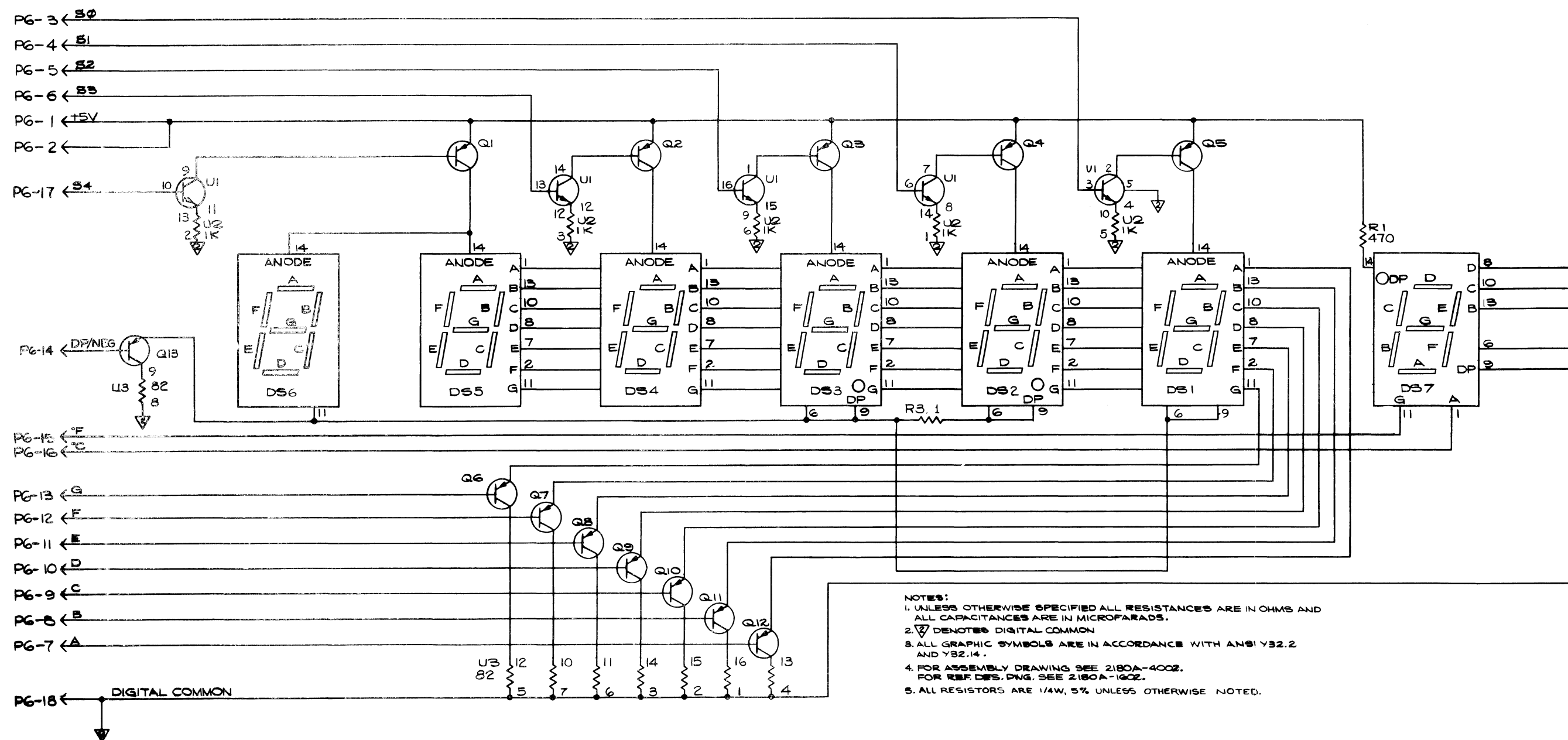
2180A-1001
(Sht 2 of 3)

Figure 8-1. A1 Main PCB Assembly (cont)



2180A-1602

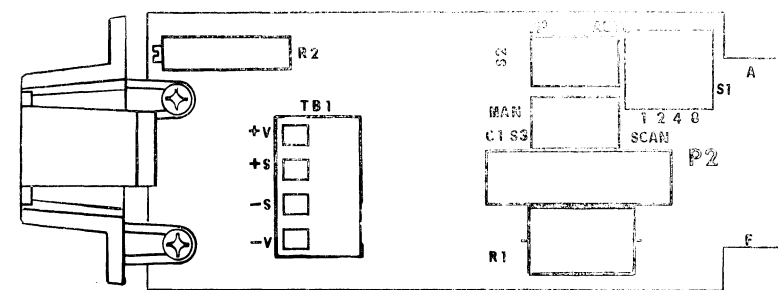
Figure 8-2. A2 Display PCB Assembly



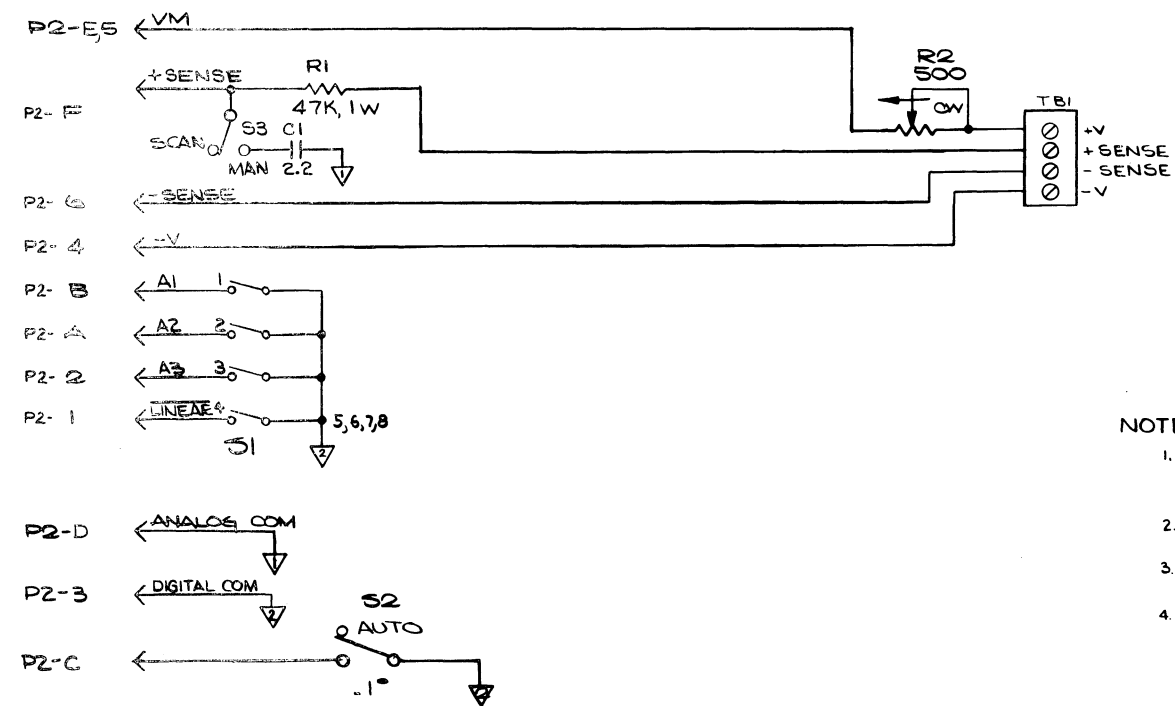
2180A-1002

Figure 8-2. A2 Display PCB Assembly (cont)

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2180A-1603

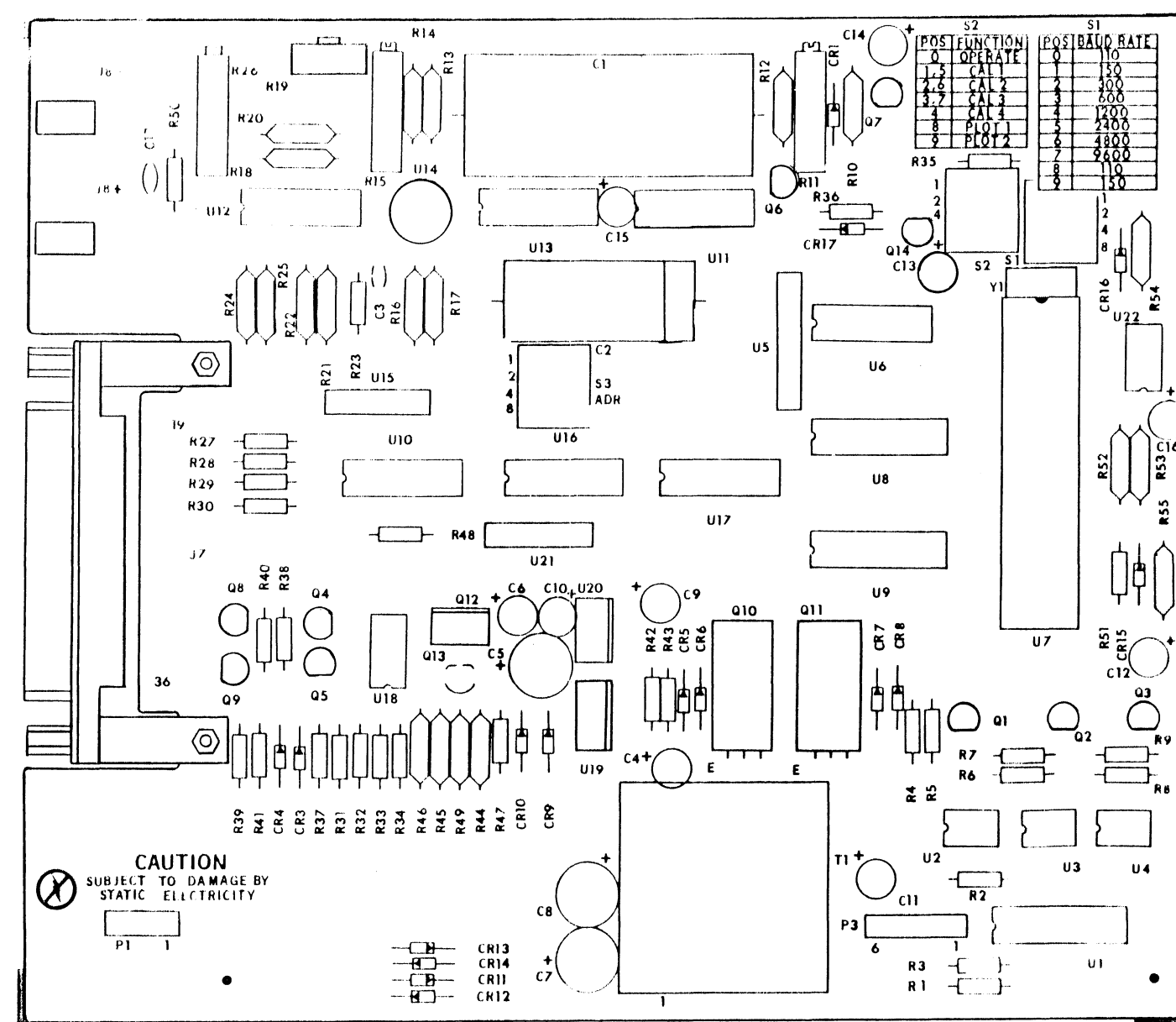


NOTES:

1. UNLESS OTHERWISE SPECIFIED ALL RESISTANCES ARE IN OHMS AND ALL CAPACITANCES ARE IN MICROFARADS.
2. ALL RESISTORS ARE 1/4W, 5% UNLESS OTHERWISE NOTED.
3. ALL GRAPHIC SYMBOLS ARE IN ACCORDANCE WITH ANSI Y32.2 AND Y32.14.
4. ▽ DENOTES ANALOG COMMON.
▽ DENOTES DIGITAL COMMON.

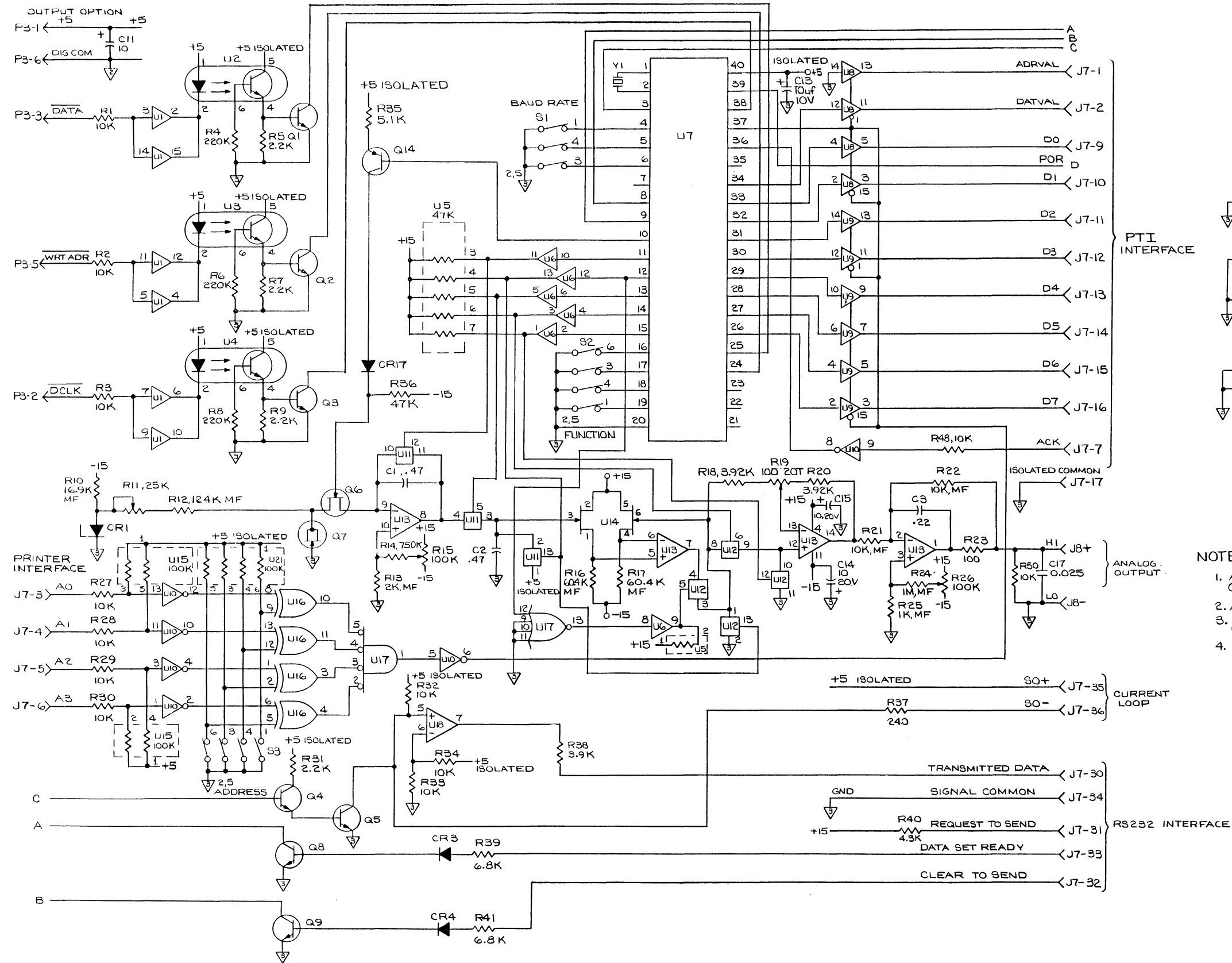
2180A-1003

Figure 8-3. A3 RTD Input PCB Assembly



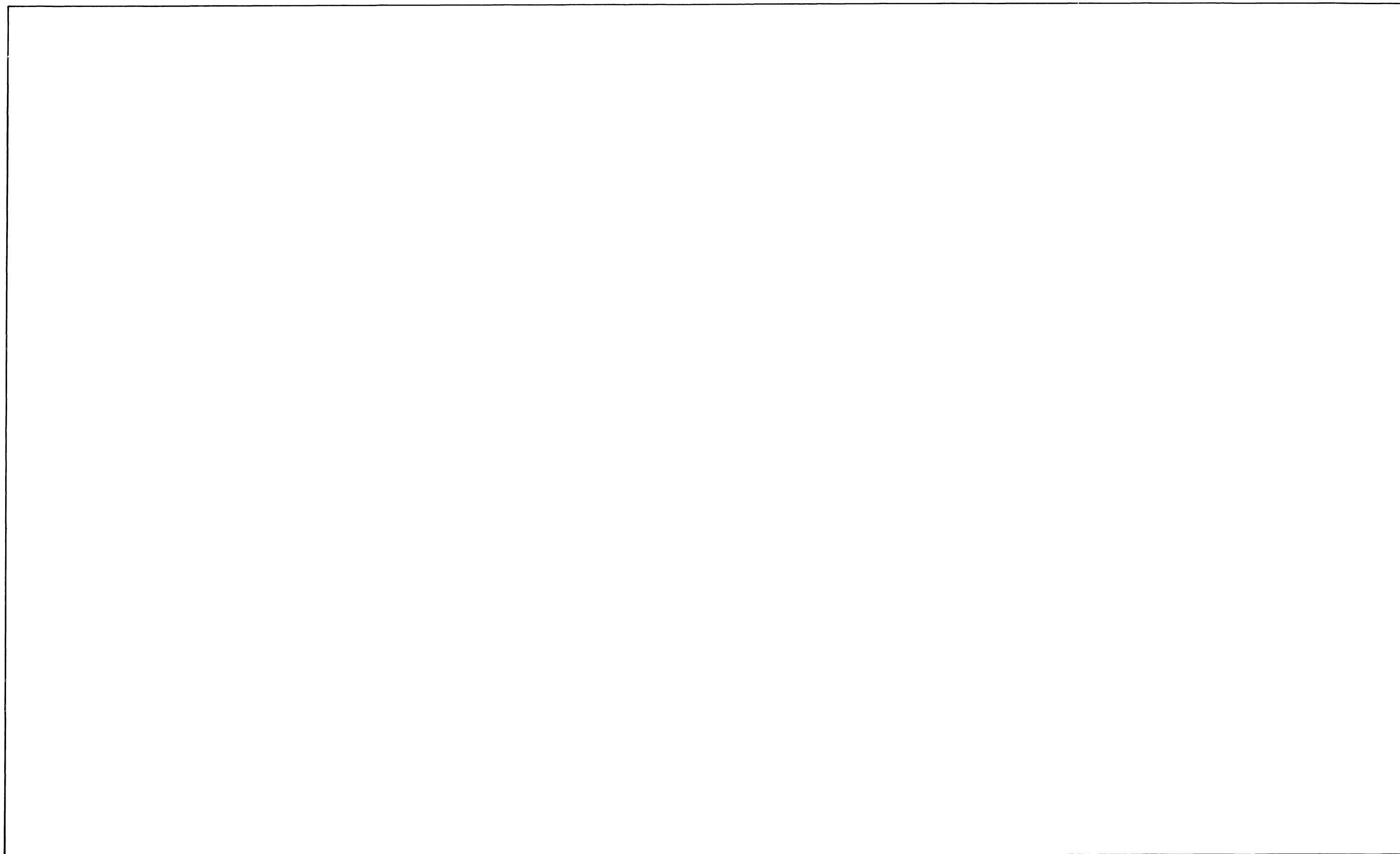
2180A-1620

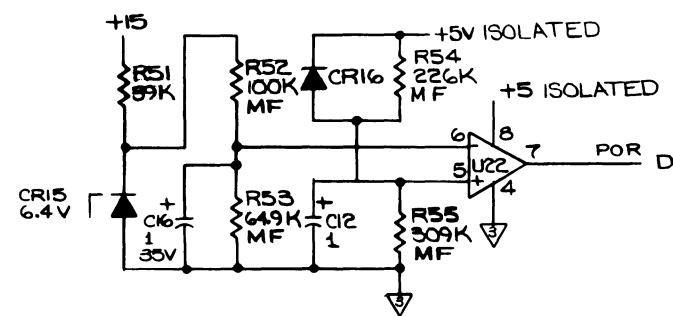
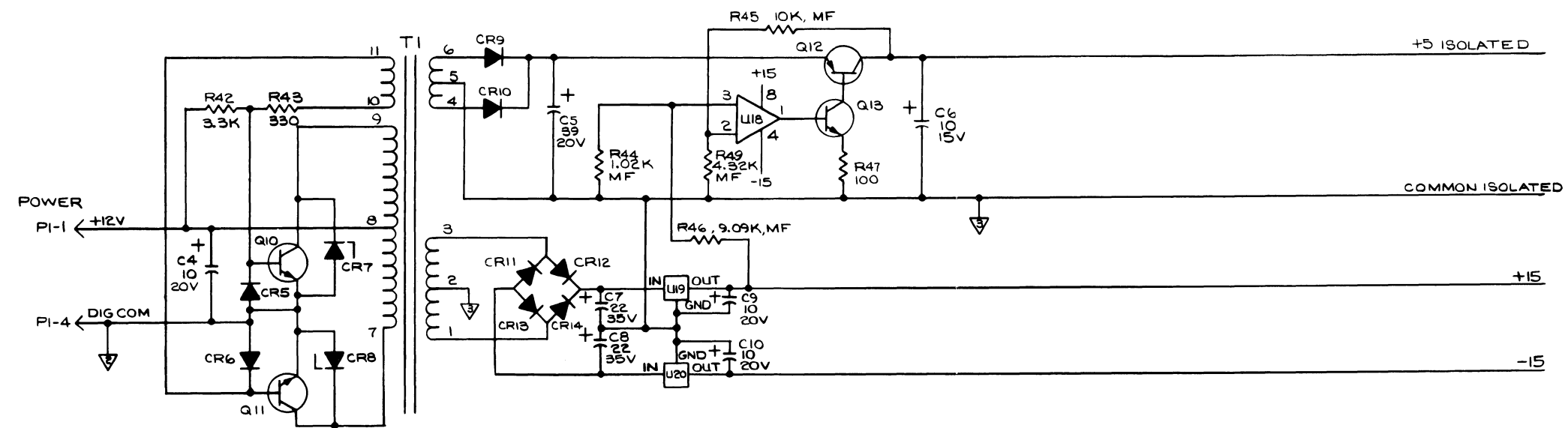
Figure 8-4. Option -002 Output PCB Assembly



2180A-1020
 (Sheet 1 of 2)

Figure 8-4. Option -002 Output PCB Assembly (cont)





REF DESIGNATIONS	
LAST USED	NOT USED
C17	
CR17	CR2
U22	
R55	
Q14	
S3	
T1	

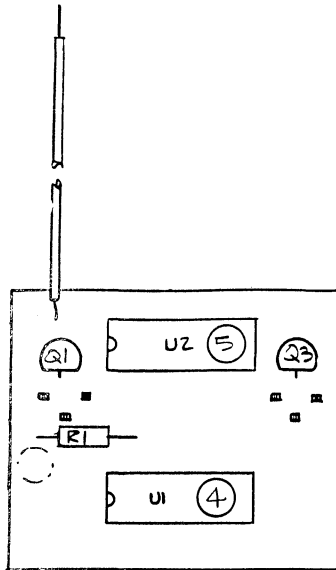
DES	+5	GND	+5 ISOLATED	+15	-15	GND ISOLATED
U1	1	8				
U2	1		5			
U3	1		5			
U4	1		5			
U5				1		
U6			14			7
U7			40			20
U8			16			8
U9			16			8
U10			14			7
U11				14		7
U12				14		7
U13				4	11	
U14				28		
U15, U21			1			
U16			14			7
U17			14			7
U18				8	4	

DES	+5	GND	+5 ISOLATED	+15	-15	GND ISOLATED
U22		4	8			

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(Sheet 2 of 2)

Figure 8-4. Option -002 Output PCB Assembly (cont)

STRIP BACK (TYP.)
TWIST & SOLDER ENDS

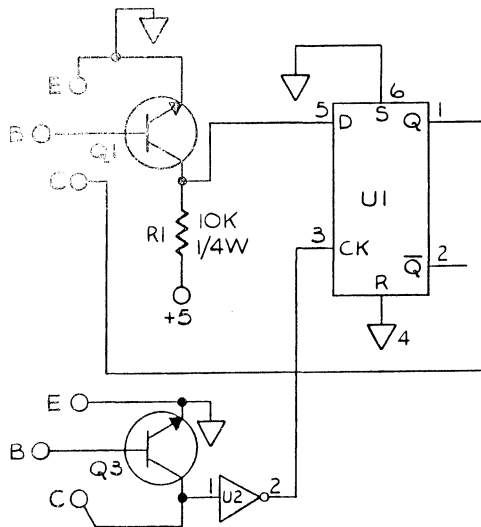


WARNING: ⓧ INDICATES USAGE OF MOS DEVICE(S)
WHICH MAY BE DAMAGED BY STATIC DISCHARGE. USE
SPECIAL HANDLING PER S.O.P. 15.7.



CAUTION
SUBJECT TO DAMAGE BY
STATIC ELECTRICITY

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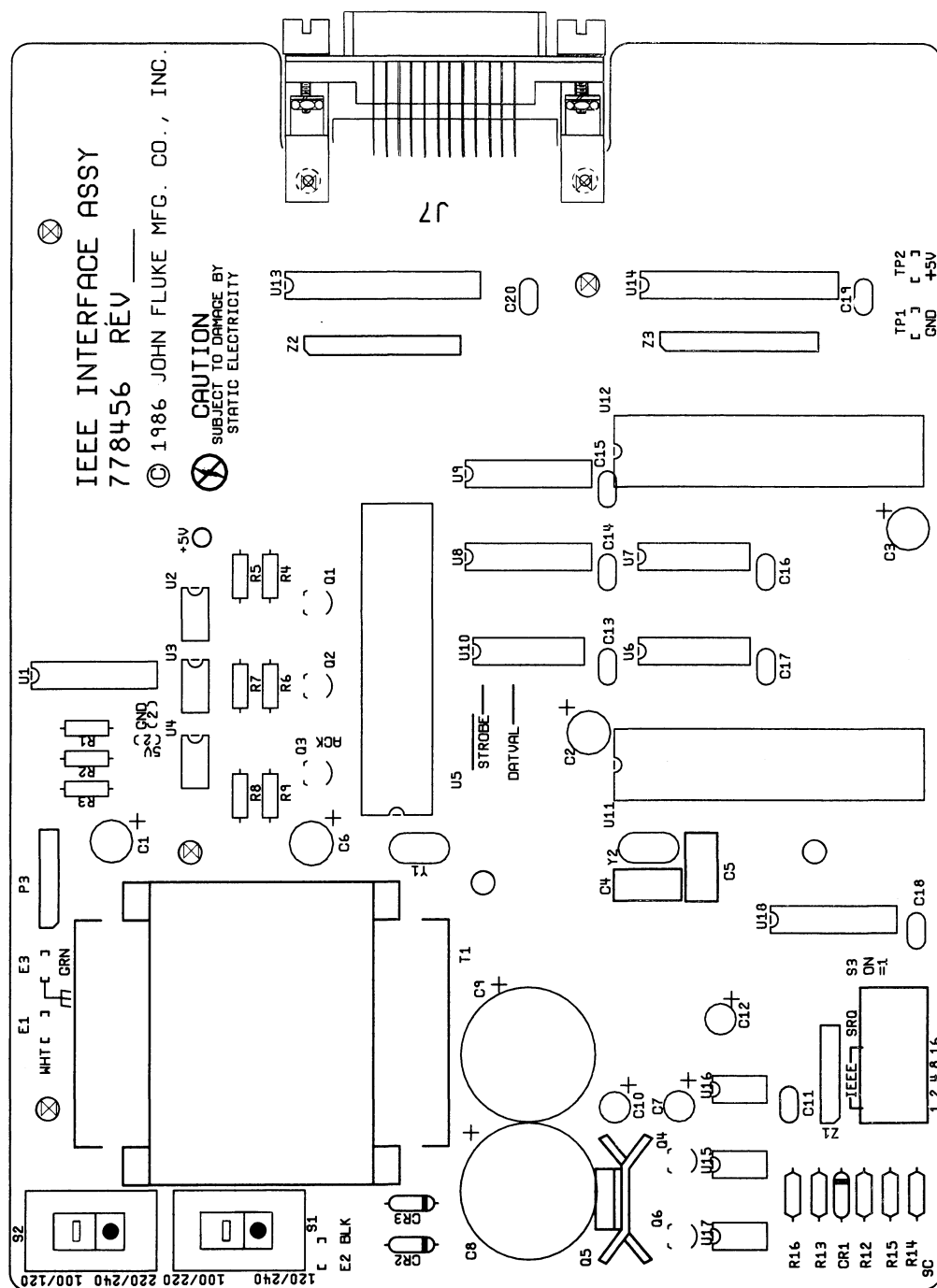
NOTES: UNLESS OTHERWISE SPECIFIED .

1. ALL RESISTANCES ARE IN OHMS .
2. ALL CAPACITANCE ARE IN MICROFARADS .
3. ALL RESISTORS ARE 1/4W, 5% .

IC	+5	GND
U1	14	7,8,9,10,11
U2	14	3,5,7,9,11,13

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

Figure 8-4A. Output Unit Adapter PCB Assembly



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Figure 8-5. Option -004 IEEE-488 Interface PCB Assembly

NOTES : UNLESS OTHERWISE SPECIFIED .

- 1. ALL CAPACITANCES ARE IN MICROFARADS.
- 2. ALL RESISTANCES ARE IN OHMS.
- 3. ALL GRAPHIC SYMBOLS ARE IN ACCORDANCE WITH ANSI Y32.2 AND Y32.14.
- 4. ALL RESISTORS ARE 1/4 W 5% CARBON FILM.
- 5.  DENOTES DIGITAL COMMON ISO.
- 6.  DENOTES DIGITAL COMMON NON-ISO.
- 7.  PINS 3,5,7,8,9,10,11,12,13,14,15,16,17,18,19,21,22,23,35.
- 8. **WARNING:**  INDICATES USAGE OF MOS DEVICE(S) WHICH MAY BE DAMAGED BY STATIC DISCHARGE. USE SPECIAL HANDLING PER S.O.P. 19.1

LAST USED	NOT USED
U18	
R16	
C20	
Q6	
CR3	
Y2	
T1	
Z3	
S3	S3 7,8




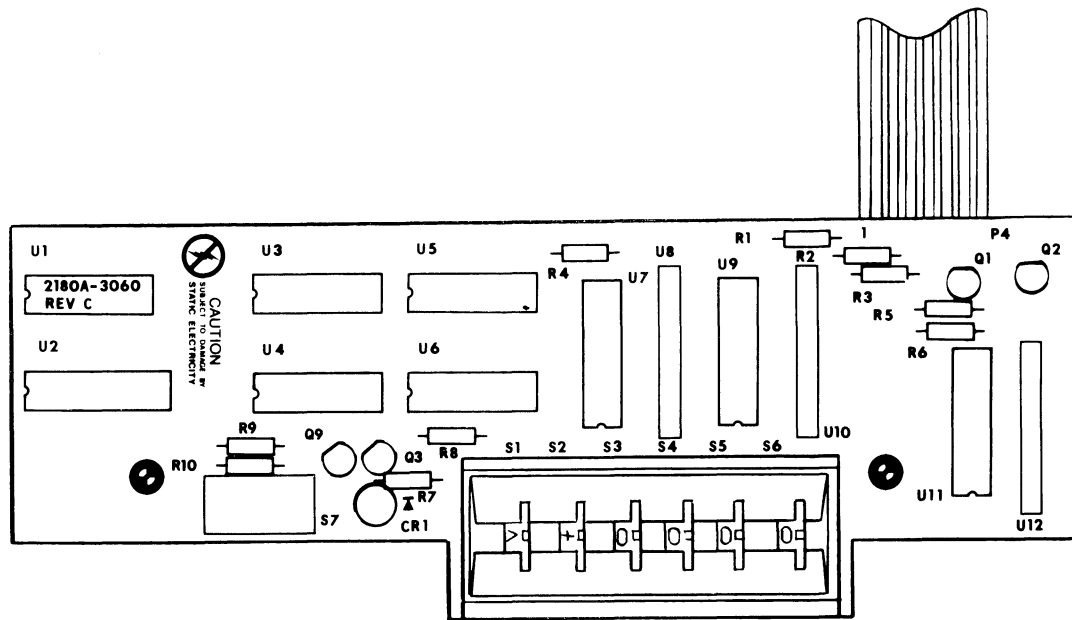
REF DES	+5 ₍₂₎		+5		NO CONNECTION
U1	1	8			13,16
U2	1		5		3
U3	1		5		3
U4	1		5		3
U5			40	4,6,20,37	
U6			14	7,12,13	11
U7			14	7,9,11,13	8,12,10
U8			15,16	8,12,14	11,13
U9			15,16	8,12,14	11,13
U10			4,14	7,11,12	9
U11			26,40	7,20,23,35,36	9,15,25,34,37,38
U12			20	1,2	15
U13			24	12,13,14	
U14			1,24	11,12,13,14	
U15			—	3	4,5,6,7,8
U16			8	4	5,6,7
U17			8	4	5,6,7
U18			14,16	8	13
J7					12
S3					8

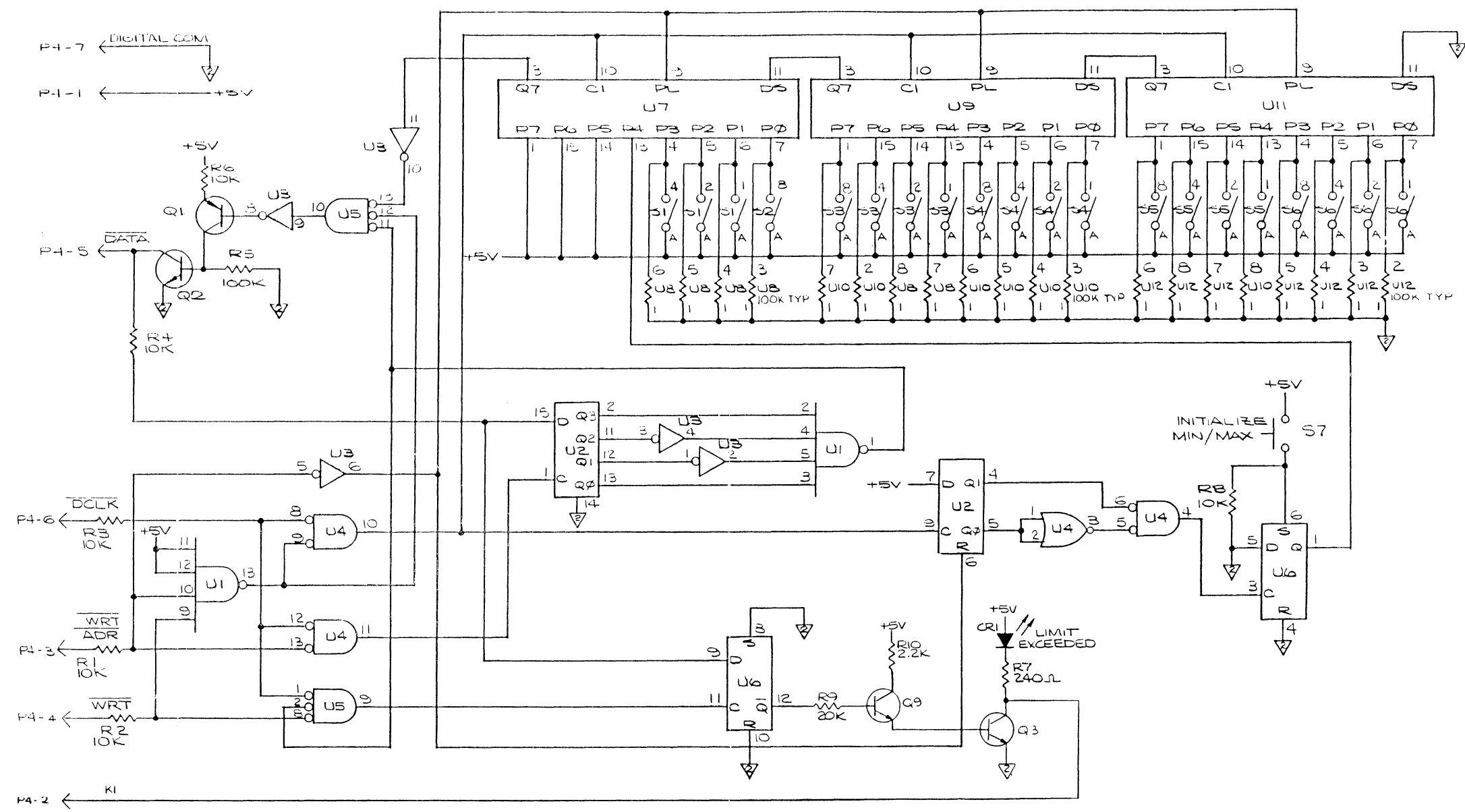


Figure 8-5. Option -004 IEEE-488 Interface PCB
Assembly (cont)

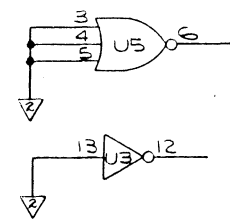


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Figure 8-6. Option -006 Limits PCB Assembly



- NOTES:
- 1. UNLESS OTHERWISE SPECIFIED ALL RESISTANCES ARE IN OHMS AND ALL CAPACITANCES ARE IN MICROFARADS.
 - 2. ALL RESISTORS ARE 1/4W, 5% UNLESS OTHERWISE NOTED.
 - 3. ALL GRAPHIC SYMBOLS ARE IN ACCORDANCE WITH ANSI Y32.2 & Y32.14.
 - 4. ∇ DENOTES DIGITAL COMMON. DIGITAL COMMON IS -15V WITH RESPECT TO ANALOG COMMON



I.C.	+5V	∇
U1	14	7
U2	16	8
U3	14	7
U4	14	7
U5	14	7
U6	14	7
U7	16	8
U8	16	8
U9	16	8
U10	16	8
U11	16	8

REF DES	
LAST USED	NOT USED
U12, R8, S1, Q3	Q4, Q5, Q6, Q7, Q8

Figure 8-6. Option -006 Limits PCB Assembly (cont)

ANALOG COM	Measurement common
AZ	Auto-Zero
CM	Compare input to the microcomputer
$\overline{\text{DATA}}$	Data on bus
$\overline{\text{DCLK}}$	Data clock
DE+	Read a plus input
DE-	Read a minus input
DIGITAL COM	-15V with respect to Analog Com
D.P./NEG	Drives decimal point, depending on reading and resolution
INT 1	Causes the unknown voltage to be integrated
$\overline{\text{LINEAR}}$	Used to command the microcomputer to display linear counts
$\overline{\text{WRT}}$	Write
$\overline{\text{WRT ADR}}$	Write address, signals that an address is being transmitted
X10	Selects a buffer gain of X10 (0.1° resolution)
X100	Selects a buffer gain of X100 (0.01° resolution)
$\Delta 2$	Hold command
+SENSE	Voltage sense wires from RTD — no current flows in these wires
-SENSE	Voltage sense wires from RTD — no current flows in these wires
+Vm	An intermediate voltage — not used directly
-V	Current return

Figure 8-7. Mnemonics